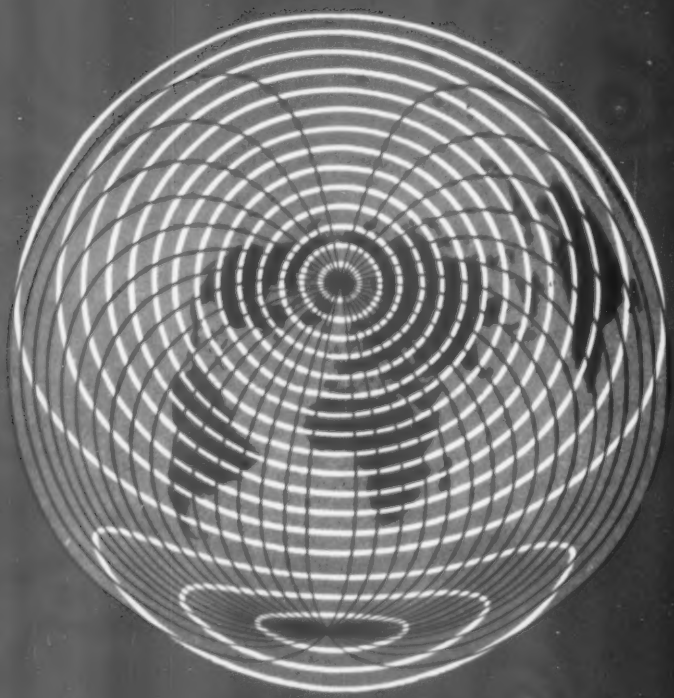
APRIL 1958

TWO SHILLINGS

Wireless World

ELECTRONICS

Radio · Television



FORTY-SIXTH YEAR OF PUBLICATION

5 good reasons for using

BICC POLYPOLE CABLE COUPLERS!

Designed for the outdoor connection of Specialized Remote Control Units, Centimetre Radio Links, Ground Radar, Television Camera and Industrial Electronic Equipment.

Moulding techniques ensure a tough, permanent, moisture-resistant assembly which virtually eliminates the possibility of conductor breakages at the coupler.

Screwed lock rings provide forced engagement and withdrawal. The overall metal housing is replaceable if damaged.

The cable itself is designed with a symmetrical cross section to provide the greatest reliability during handling.

The conductors are embedded in the moulding in the same geometric formation as in the cable so that each contributes to the strength of the connection.

Both panel mounting and cable couplers can be supplied with insulated tails and cable lengths respectively cut to meet individual requirements.

Full details of our standard range of Polypole Couplers and Cables are available on request.

BICC are always glad to advise on the use of Polypole Couplers and Cable to meet customers' special requirements.

BICC Callender's

BRITISH INSULATED CALLENDER'S CABLES LIMITED

21 BLOOMSBURY STREET, LONDON, W.C.1

Photograph by courtesy of British Insulated Callenders' Cables, Ltd.

Avo in action..

The checking of a busbar installation in a large steel works is an interesting example of the important contribution of the world-famous AvoMeter to the maintenance of electrical power plant. AvoMeters will be found wherever electricity is used in industry.

Model 40 Universal AvoMeter

A self-contained multi-range A.C./D.C. instrument providing 40 ranges of direct readings of current, voltage and resistance on a 5-inch hand calibrated scale fitted with an anti-parallax mirror. Range selection is by two rotary switches, for A.C. and D.C. respectively, and a press button provides additional ranges by halving the current and voltage ranges shown on the switch knobs. The total resistance of the meter is 200,000 ohms.

The instrument is compact and portable, and is protected by an automatic cut-out against damage through the inadvertent application of overload.

Power Factor and reactive kV.A. can be measured in A.C. circuits by means of an external accessory (the Universal AvoMeter Power Factor & Wattage Unit).

Size: 8 × 7½ × 4½ ins.
Weight: 6½ lbs.

List Price **£19 : 10s.**

...you can depend on AVO

Sole Proprietors and Manufacturers:—

THE AUTOMATIC COIL WINDER & ELECTRICAL EQUIPMENT CO., LTD.

AVOCET HOUSE • 92-96 VAUXHALL BRIDGE ROAD • LONDON • S.W.1. *Telephone: VICtoria 3404 (9 lines)*

A.40/3
A

Suflex

and miniaturisation

This handsome Great Dane is a gloomy Dane.
Demands are so stringent—he just doesn't fit in.
But practically any space at all is snug for
this pocket-sized Mexican, the Chihuahua
(pronounced Chihuahua, or any old way, he doesn't care).
If you are driven despondent by problems of size and weight,
you could not do better than contact Suflex.

Suflex Polystyrene Capacitors

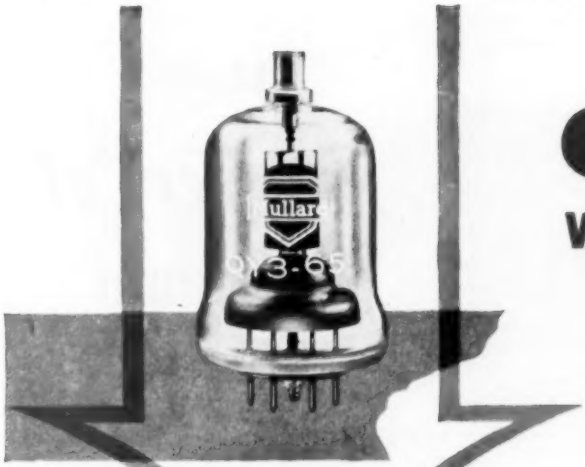
- **High insulation resistance**
- **Low dielectric loss**
- **Good capacitance stability**

A quality component which may be economically used in commercial equipment

SUFLEX Limited
LONDON

15 BAKER STREET, LONDON W1

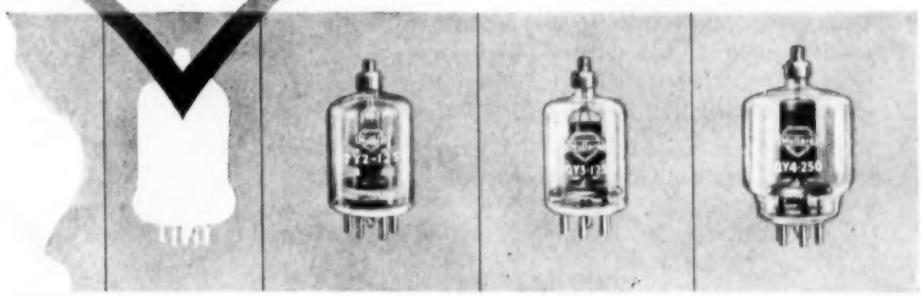
Telephone: WELbeck 0791 *Cables:* Suflex, London



QY3-65

V.H.F. POWER TETRODE

a new addition to a popular range



This new tetrode, the QY3-65, embodies a similar technique and construction to the Mullard range of all-glass transmitting valves which are already well established in communications and industry. It has an anode dissipation of 65 watts and a maximum frequency of 250 Mc/s and is directly interchangeable with the American 4-65A.

Relatively high outputs can be obtained from the QY3-65 at low anode voltages, and its quick heating filament allows power consumption during standby to be reduced to a minimum.

Write for detailed information on this valve, power triodes and other tetrodes made by Mullard.

MAXIMUM OPERATING CONDITIONS (CLASS C AMPLIFIER) AT 50 Mc/s									Maximum frequency at reduced ratings (Mc/s)
Valve	Type	V_a (V)	V_{g1} (V)	I_a (mA)	I_{g1} (mA)	V_{in} (peak) (V)	P_{load} (W)	η %	
QY3-65 (CV1905)	**TETRODE**	**3000**	**-100**	**115**	**10**	**170**	**324**	**81**	**250**
TY2-125 (CV1924)	TRIODE	2500	-200	205	40	390	310	76	200
QY3-125 (CV2130)	TETRODE	3000	-150	167	6.5	300	300	75	200
QY4-250 (CV2131)	TETRODE	4000	-225	312	9	374	800	80	120

Mullard MULLARD LTD., COMMUNICATIONS & INDUSTRIAL VALVE DEPT., CENTURY HOUSE, SHAFTESBURY AVENUE, LONDON, WC2

MVT184

for

Band III Convertors

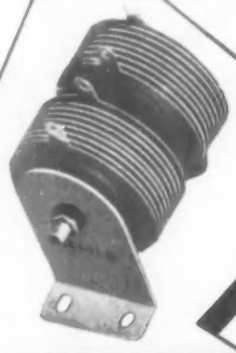
use

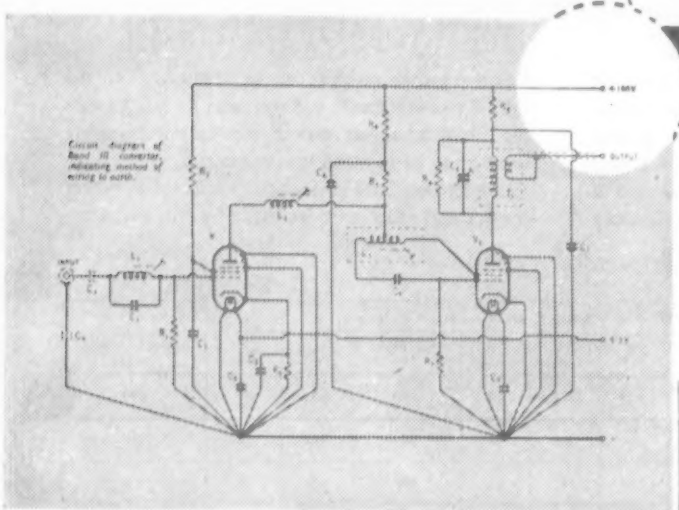
SenTerCel selenium rectifiers

as recommended in the "Wireless World" *(May 1954 issue)*

From a range of miniature rectifiers designed for domestic Radio and Television receivers, types RM0 and RM1 are recommended for use in T.V. Band III Converters.

It may be covenient to use type DRM1 ; an assembly of two RM1 rectifiers on a spindle and bracket.





SELENIUM *SenTerCel* RECTIFIERS

Send for Brochure F/SRT.9

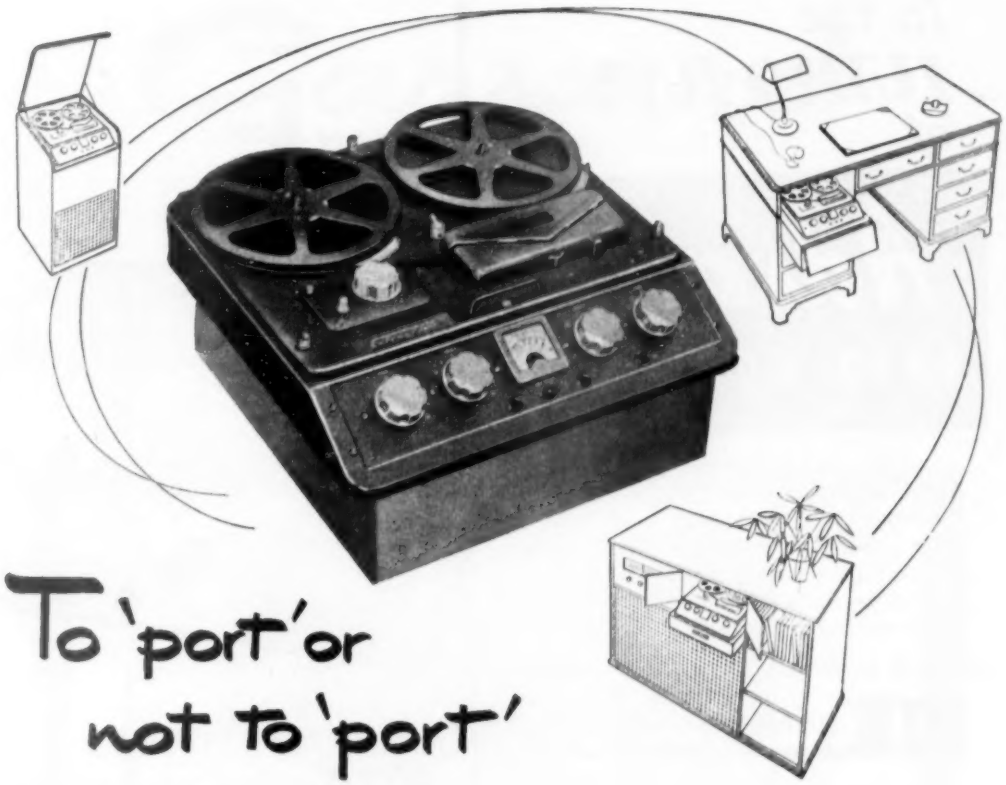
TYPE	RM0	RM1
Maximum ambient temperature	35°C 55°C	35°C 55°C
Maximum output current (mean)	30mA 15mA	60mA 30mA
Maximum input voltage (r.m.s.)	125V	125V
Maximum peak inverse voltage	350V	350V
Max. instantaneous peak current	Unlimited	Unlimited
Weight	0.82 oz.	1 oz.

Standard Telephones and Cables Limited

(Registered Office: Connaught House, Aldwych, W.C.2)

RECTIFIER DIVISION: Edinburgh Way, Harlow, Essex.

Telephone: Harlow 26811 Telegrams: Sentercel, Harlow, Essex



To 'port' or not to 'port'

Yes—that is the question! And a very important question, too. For portability in a Tape Recorder isn't always an advantage. It can, indeed, prove a costly handicap if valuable—and irreplaceable—recording opportunities are lost because the instrument is not set up for immediate use.

So, if it is not your intention to carry your Tape Recorder around, we know you'll be interested in the new Ferrograph '66'. Tape Recording is no longer something to amuse (and amaze) your friends. It's a serious business—an opportunity to capture for your future enjoyment the spine-tingling glories of great music. And you'll do it with greater certainty if your Recorder is always ready for instant use.

By the omission of an inbuilt loudspeaker it has been possible—without sacrificing even one of its many valuable features—to design the Ferrograph '66' so that its main baseplate substantially overlaps the high fidelity amplifier beneath it. Thus, it is child's play to fit it into a console, a desk, a bookcase, or, in fact, any suitable piece of furniture of period or contemporary design. All that is necessary is to provide a wood surround with an opening 15¾" × 16½" on which it can be mounted. If a single drawer is too shallow, an adjacent pair can be easily converted for the same purpose.

The '66', basically a series 2 Ferrograph in a new form, is a most versatile instrument. By mounting it alongside a turntable and an F.M. tuner, you can have at the turn of a switch recording from the three sources of microphone, radio and pickup with the added advantage of using the Ferrograph hi-fi amplifier separately for disc-playing or radio if desired.

Most attractively finished in gold bronze with cream knobs and accessories, the ensemble will readily harmonise with the most luxurious surroundings and permit tape recording and playing at its best to be always available at the turn of a switch.

Model 66.N
3¾" & 7½" p.s.
84 gns.

Model 66.H
7½" & 15" p.s.
88 gns.

(including 1750 ft. Ferrotape on 8½" reel)

Ferrograph
"66"

BRITISH FERROGRAPH RECORDER CO. LTD
131 SLOANE STREET · LONDON · S.W.1 · Tel: SLOANE 2214/5 and 1510

In the AUDIO RANGE *of*

Advance
TEST EQUIPMENT

15 c/s to 50,000 c/s

These two most modestly priced models, in common with the comprehensive " Advance " range (which completely covers from Audio to U.H.F.) have earned a reputation second-to-none the world over for accuracy, simplicity in use, and consistent reliability.

FOR THE COMMUNICATIONS ENGINEER

J1 SIGNAL GENERATOR

Covers from 15-50,000 c/s in three ranges. Accuracy ± (2% + 1 c/s). Output (continuously variable) into 600 ohms. 0.1mW-1W (0.25-25v) ± 2db, output impedance approximating to 600 ohms over the whole range. Maximum output into 5 ohms is greater than ½W.

LIST PRICE IN U.K. **£35 12s.**

Type J2 similar to J1 but with output voltage meter. LIST PRICE IN U.K. **£45**

Full technical details in Leaflet W29

FOR THE AUDIO ENGINEER

H1 SIGNAL GENERATOR

Covers from 15-50,000 c/s in three ranges. This model is characterised by its extremely low distortion and level output over the entire range. Accuracy ± 1% ± 1 c/s. Output from 200 micro-volts to 20 volts with an accuracy of ± 2 db.

STABLE OUTPUT OVER FULL RANGE

•

SINE OR SQUARE WAVE OUTPUT

○

DISTORTION LESS THAN 1% AT 1,000 c/s

LIST PRICE IN U.K. **£28**

Full technical details in Leaflet W16

ADVANCE COMPONENTS LTD., ROEBUCK ROAD, HAINAULT, ESSEX

Telephone : HAInault 4444

Garrard

AUDIO PERFECTION

301 TRANSCRIPTION MOTOR

THE GARRARD MODEL 301 TRANSCRIPTION MOTOR

The Garrard Model 301 Transcription Motor is recognised as supreme in its class. With its introduction a hitherto unattainable standard in the manufacture of High Fidelity Gramophone Components has been reached. Features that the enthusiast will appreciate are the suppression of switch clicks, the extra heavy balanced turntable and the very fine degrees of speed control available . . . all three speeds, 78, 45 and 33⅓ r.p.m., can be adjusted by approximately 2½%.

Wow and Flutter have been reduced to the minimum, being less than 0.2% and less than 0.05% respectively. The unit is equipped for dual voltage ranges of 100 to 130 and 200 to 250 volts, 50 or 60 cycles according to the motor pulley fitted.

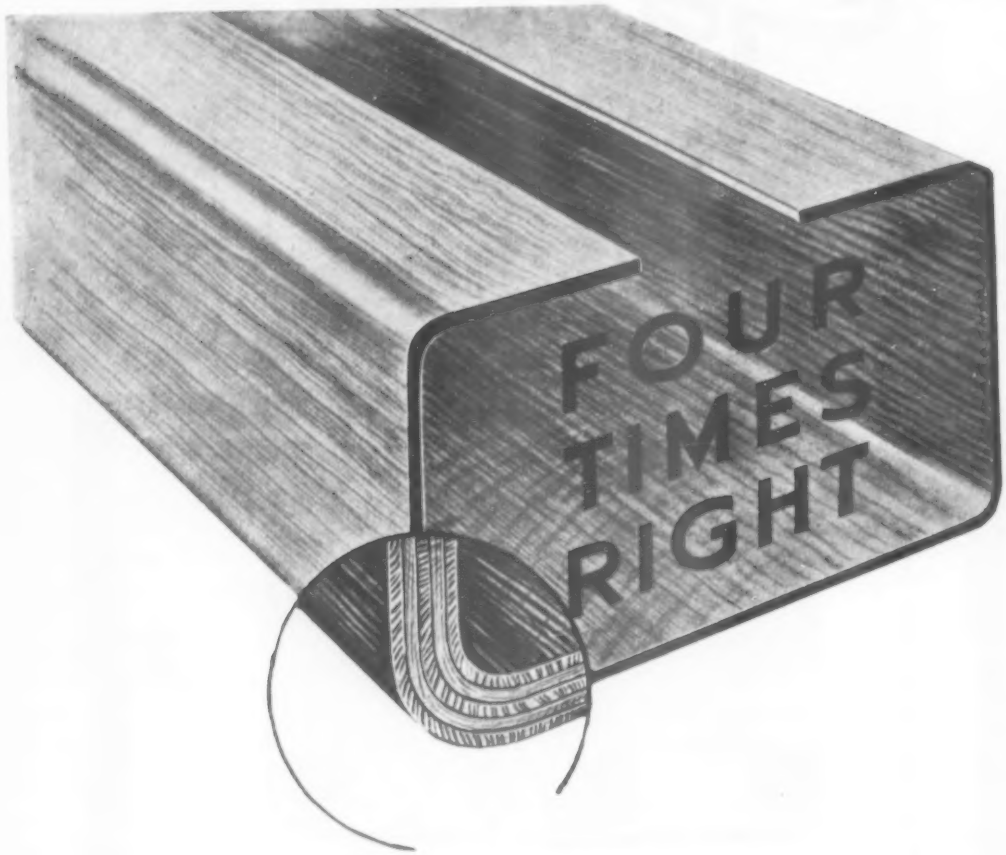
The Model 301 is finished in high quality grey tone enamel, is fully tropicalised and is supplied complete with a plastic stroboscope, a tube of special grease, all fixing screws, washers, template and instruction manual.

. . . . see your Dealer now.

THE GARRARD ENGINEERING AND MANUFACTURING CO., LTD.

Swindon, Wilts, England

THE SPEARS-LAMINA SHELL



The SPEARS-LAMINA plywood shell has four complete right angles, pre-formed without cutting, steaming or stressing, and giving immense strength to the structure. The shell is made in thicknesses from 2 millimetres to 2 inches, radii from $\frac{1}{2}$in. upwards, dimensions from a few inches to 6 feet every way. Besides rectangles, any shape can be made which does not include a concavity. Minimum quantities are 10,000 of a pattern, and delivery at the rate of 500 to 5,000 per week.

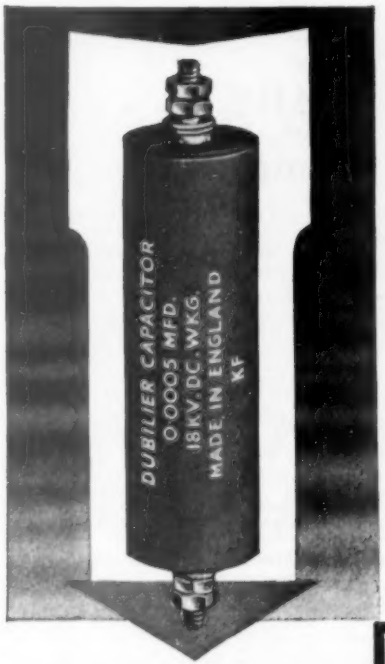
The shell is especially well adapted for the Radio and Television industries, and experience indicates that the cost of a cabinet can be easily halved by the use of this shell. Enquiries are invited from cabinet manufacturers.

Special Notice

The SPEARS-LAMINA Shell is manufactured by Matthew Spears and Company Limited, Kirkcaldy, under Mr. James Henderson's Patents. All proper steps will be taken to protect the Patent rights in the case of any apparent infringement.

MATTHEW SPEARS AND COMPANY LIMITED

LAMINA WORKS – KIRKCALDY – SCOTLAND



New!

E.H.T. CAPACITOR

Type 500 H.T. oil-filled capacitor in non-metallic case

PLASTIC CASE ELIMINATES CORONA EFFECTS

HERMETICALLY SEALED

SINGLE HOLE FIXING

Terminations		$\frac{7}{16}$" x 4 B.A.		$\frac{7}{16}$" x 4 B.A.		$\frac{1}{2}$" x 2 B.A.	
Tube Size		Dia.	Len.	Dia.	Len.	Dia.	Len.
D.C. Rating 70° C. Wkg.	Test	$\frac{13}{16}$"	$2\frac{3}{8}$"	$1\frac{1}{4}$"	$2\frac{3}{8}$"	$1\frac{1}{4}$"	$3\frac{1}{8}$"
2.0 kV.	4.0 kV.	0.05 μF.		0.1 μF.		0.15 μF.	
4.0 kV.	8.0 kV.	0.01 μF.		0.02 μF.		0.03 μF.	
5.0 kV.	10.0 kV.	0.0075 μF.		0.015 μF.		0.02 μF.	
8.0 kV.	16.0 kV.	0.002 μF.		0.005 μF.		0.0075 μF.	
10.0 kV.	20.0 kV.	0.0015 μF.		0.003 μF.		0.005 μF.	
12.0 kV.	24.0 kV.	0.001 μF.		0.002 μF.		0.003 μF.	
15.0 kV.	30.0 kV.	0.0007 μF.		0.0015 μF.		0.002 μF.	
18.0 kV.	36.0 kV.	0.0005 μF.		0.001 μF.		0.0015 μF.	
20.0 kV.	40.0 kV.	0.0003 μF.		0.0007 μF.		0.001 μF.	
25.0 kV.	50.0 kV.	0.0002 μF.		0.0005 μF.		0.00075 μF.	
30.0 kV.	60.0 kV.	—		—		0.0005 μF.	

The capacitance value is a nominal maximum for a given tube size and voltage rating, capacitance tolerance ± 20%.

DUBILIER

DUBILIER CONDENSER CO. (1925) LTD

DUCON WORKS, VICTORIA RD., NORTH ACTON, W.3. Telephone: ACORN 2241. Telegrams: HIVOLTCON, WESPHONE, LONDON

Better Listening . . .

with E·A·R Amplifiers

E.A.R's wide experience in the field of sound-reproducing equipment has made possible the introduction of a range of Amplifiers able to satisfy the most exacting requirements, yet priced within the reach of all.

E·A·R Three-Nine-Five

45 gns.

The principal features of the E.A.R Three-Nine-Five Amplifier based on a circuit developed by Mullard can be summarised as follows:—

1. Very low harmonic (less than 0.05% at 20 watts 400 c/s) and intermodulation distortion (at 40 c/s and 10 kc/s (ratio 4:1)—0.7% at 20 watts).
2. Linear frequency response in the audible range.
3. Good response to signals of a transient nature.
4. Low phase shift in the audible frequency range.
5. Low hum and noise level.
6. Adequate power output to allow peak passages to be reproduced without overload.
7. Low output resistance to provide electrical damping for the loudspeaker system.

These claims are amply supported by a technical specification which creates a new standard of performance for commercially produced amplifiers.

Brief Technical Details—E·A·R Three-Nine-Five Amplifier

POWER AMPLIFIER

The amplifier has an output stage of two EL34 valves operated under distributed load conditions, giving high power handling capacity with low distortion. The output transformer uses the latest type of grain oriented steel, and has been specially designed to realise the high potentialities and exacting specification of the amplifier. Negative feedback is applied overall, the high value of which, combined with the low inherent output impedance of the output stage, gives at 20 watts output on a 15 ohm load a measured output impedance of 0.3 ohm. This corresponds to a damping factor of approximately 50.

CONTROL UNIT

The Control Unit has five controls: input selector, volume, bass and treble, and a filter switch. Two positions only are provided on the input for record playback, the one for L.P. being based on R.I.A.A. and the one for standard on the suggested E.M.I. characteristic. The majority of record manufacturers are recording normally to the R.I.A.A. characteristic and those remaining are sufficiently close to make it possible to compensate for the difference by the judicious use of the wide range tone controls available. The filter switch has three positions: 5 kc/s., 10 kc/s., and 20 kc/s.

E·A·R Six-Ten-P

23 gns.

The Six-Ten-P shown here features a 10-watt amplifier with very low distortion (less than 0.2% total harmonics), together with a separate control unit enabling all types of pickups to be used, including low sensitivity variable reluctance heads.

The control unit, developed by E.A.R, employs two of the latest low-noise pentodes (EF86) with negative feedback loops. The wide range tone controls are fully adequate to compensate for any variation in acoustic conditions. 23 gns.

Other Amplifiers in the E·A·R Range

SIX-TEN

POWER OUTPUT: 10 watts min.
14 watts max. (approx.)
HARMONIC DISTORTION:
Less than 0.3% at 10 watts 400 c/s.

19 gns.

FIVE-TEN

POWER OUTPUT: 10 watts min.
14 watts max. (approx.)
HARMONIC DISTORTION:
Less than 0.3% at 10 watts 400 c/s.

18 gns.

SEVEN-FIFTY

POWER OUTPUT: 4 watts.

Comprises the amplifier section of the famous E.A.R A750 Record Reproducer.

9 gns.

Produced by the makers of E·A·R Gramophones

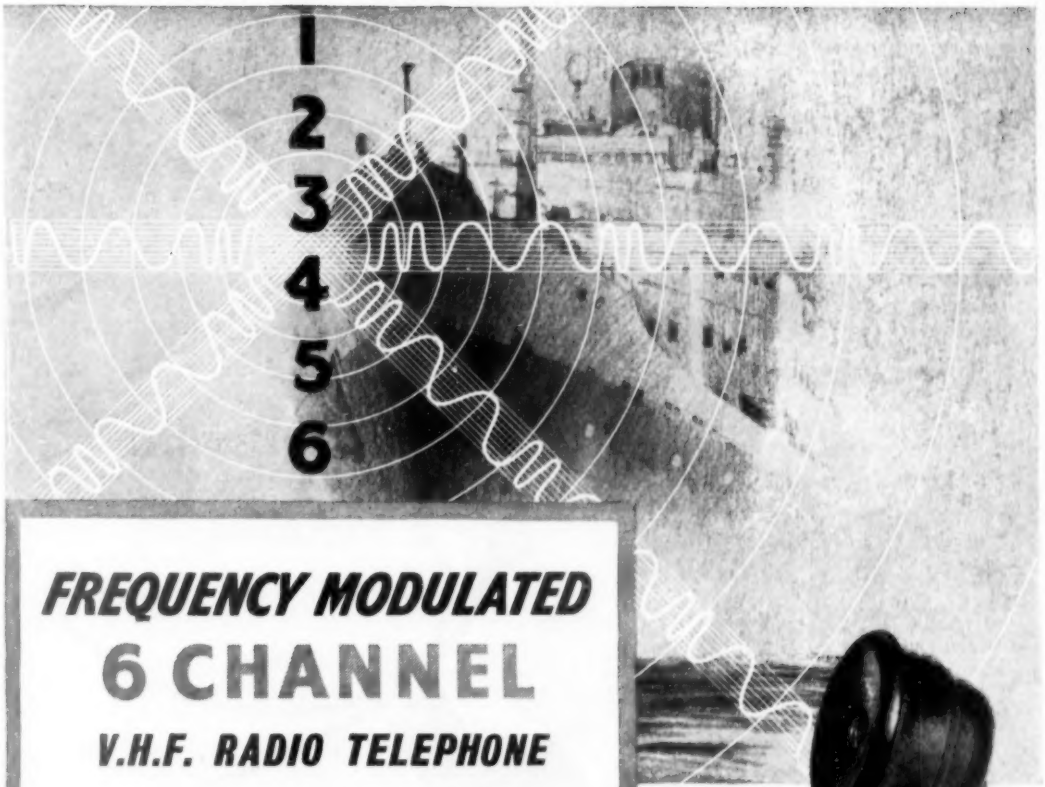
Write for full details of E·A·R Amplifiers to:—

AMPLIFIER DIVISION:

ELECTRIC AUDIO REPRODUCERS LTD.

THE SQUARE · ISLEWORTH · MIDDX. *Telephone: HOUnslow 6256-8*

EAR



FREQUENCY MODULATED
6 CHANNEL
V.H.F. RADIO TELEPHONE

Automatic Telephone and Electric Co. Ltd., designers and suppliers of the world's largest V.H.F. Harbour Communication Scheme, offer you the most efficient form of communications, ashore and afloat

The new Frequency Modulated V.H.F. equipment can operate on the three international frequencies and up to three additional channels in the 156.0 to 156.9 Mc/s band.

These international Frequencies are in accordance with the recommendations of the Baltic and North Sea Radiotelephone Conference 1955 at which an informal agreement on the future of maritime V.H.F. was reached.

THE INTERNATIONAL CHANNELS ARE:

SAFETY ..... 156.8 *Mc/s*

DOCK & HARBOUR SERVICE 156.6 *Mc/s*

INTER SHIP . . . . . 156.3 *Mc/s*

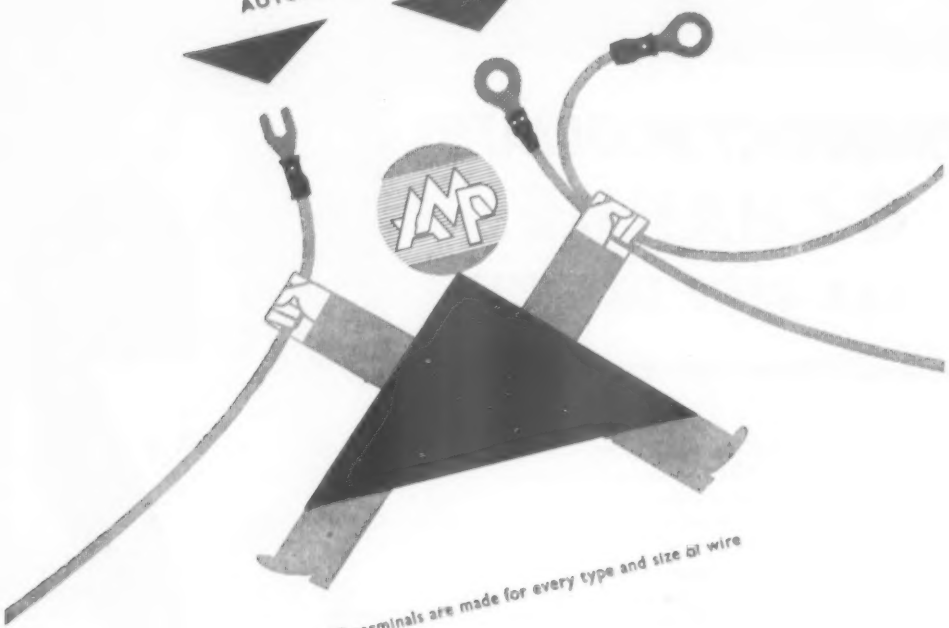
For full details of the new equipment, please write to:—

AUTOMATIC TELEPHONE & ELECTRIC CO. LTD.
RADIO & TRANSMISSION DIVISION
STROWGER HOUSE · ARUNDEL ST · LONDON W.C.2 Telephone: Temple Bar 9262. Telegrams: Strowgerex London.

AT14561-BX107

AMP solderless wiring systems for automation

ELIMINATE REJECTS
LOWER ASSEMBLY COSTS
AUTOMATIC OR MANUAL APPLICATION



AMP terminals are made for every type and size of wire

Brochure W.W. sent, or demonstration at your own Works on request

AIRCRAFT-MARINE PRODUCTS (GT. BRITAIN) LIMITED

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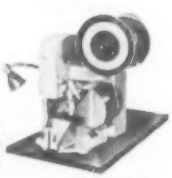


AP 323-11

A stampede of wild elephants ?

No, just the larva of a common moth eating its dinner! And what has this to do with loudspeakers

Just this—in sound reproduction as in entomology—real progress can only be achieved by specialisation

For more than 25 years, we have specialised in the design and manufacture of loudspeakers and our products are outstanding testimony to the progress which such specialisation can achieve.

R&A LOUD-SPEAKER MANUFACTURERS TO THE RADIO INDUSTRY SINCE 1930

REPRODUCERS AND **AMPLIFIERS** LTD.
WOLVERHAMPTON
ENGLAND

LOCKWOOD

VISION CONTROL DESK
B.B.C. TELEVISION SERVICE LIME GROVE.
Constructed by **LOCKWOOD** *and Designed in Conjunction with the B.B.C. Planning & Installation Dept.*

Photograph By Permission
THE BRITISH BROADCASTING CORPORATION

AND

THE **LOCKWOOD**
Standard Loudspeaker Cabinet

ACCEPTED AS A STANDARD FOR HIGH QUALITY REPRODUCTION BY BROADCASTING, TELEVISION AND RECORDING STUDIOS

AS RECENTLY DEMONSTRATED AT THE

LONDON ***AUDIO FAIR***

WITH

THE **PLESSEY** IONOPHONE
THE PLESSEY CO. LTD. ILFORD, ESSEX

AND

THE **KELLY** RIBBON SPEAKER
THERMIONIC PRODUCTS LTD. SOUTHAMPTON

LOCKWOOD & CO. (WOODWORKERS) LTD. LOWLANDS ROAD, HARROW, MDX.

Announcing

The first of the Elac
"ELMAG"
Series of
High Fidelity Units

9 x 5 Elliptical Speaker
Type 59T.

This unit is designed to give good quality at domestic volumes, it can be operated successfully in conjunction with a normally good receiver.

Where a Power Amplifier of the Mullard 510 or similar type is contemplated 4 units are recommended. Suggestions for cabinet designs are available on application.

Flux Density, 8000 gauss (27,500 Maxwells) Frequency Response 40-12,000 Cps.

RETAIL PRICE.....38/2 inc. Tax
With Transformer .....49/4 inc. Tax

ELAC

ELECTRO ACOUSTIC INDUSTRIES LTD

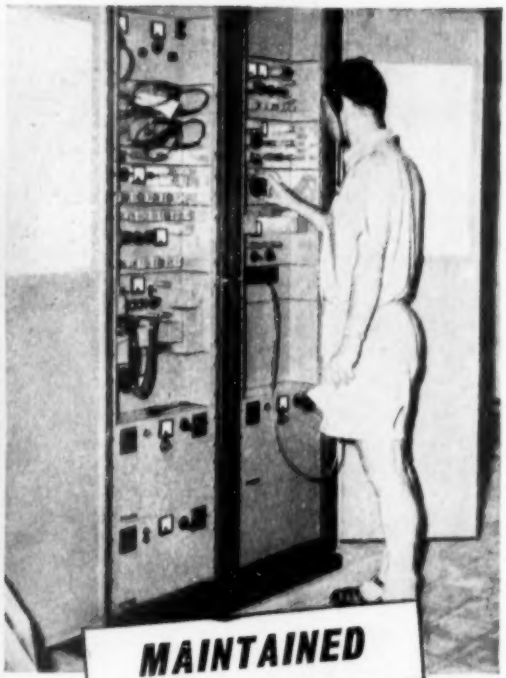
STAMFORD WORKS, BROAD LANE, TOTTENHAM, N.15 TEL: TOTtenham 0505-9

MARCONI

V. H. F. MULTI-CHANNEL SYSTEMS

VHF radio-telephony was welcomed in its early days as an economic means of providing communication over terrain where the cost and difficulty of erecting line or cable routes was prohibitive. Today Marconi's have developed multi-channel systems which, by employing frequency modulation to widen the bands, provide up to 48 telephone channels and are recognised as being preferable to line systems in many instances on grounds of performance as well as installation cost.

COMPLETE COMMUNICATION SYSTEMS — *all the world over*



Over 80 countries now have Marconi-equipped communication systems. Many of these are still giving trouble-free service after more than 20 years in operation.

The lifeline of communication
is in experienced hands

MARCONI

Complete Communication Systems

MARCONI'S WIRELESS TELEGRAPH COMPANY LIMITED, CHELMSFORD, ESSEX.

LC 17

G.E.C.

ALUMINISED C.R. TUBES

The G.E.C. 14 in. Cathode Ray Tube type 7203A has the following attractive features:—

1) Improved tube life and reliability.

2) A narrow beam angle *triode* gun giving:—

(a) Uniform focus over the entire screen area.

(b) Small spot size.

(c) Freedom from astigmatism.

3) A high reflectance aluminium backing to the fluorescent screen giving:—

(a) 70% increase in picture brightness.

(b) High contrast daylight viewing.

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Soldering operations are not notably glamorous — but how much depends on the efficiency and economy with which they are carried out! Always the quality and dependability of your own products. Often, in the long run, the difference between profit and loss.

By relying on ENTHOVEN for all your soldering requirements you are banking on the best known name in the industry — a name that represents nearly 150 years experience in non-ferrous metals and a proud record of achievement in research and development.

There is an ENTHOVEN SOLDER PRODUCT for every engineering and manufacturing requirement. Please write today for our newly revised Brochure or consult us quite freely on your particular problems.

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Flux Cored Wires. "Entocene" Solder Paints. Soft Solders in Sticks, Ingots, Sheet, and Wire. Soldering Fluxes. Cored and Solid Solder Pre-forms. Tin, Lead, and Solder Powders. "Entoloy" Casting Alloys. Tin/Zinc Alloys. Low Melting Point and High Temperature Service Solders.

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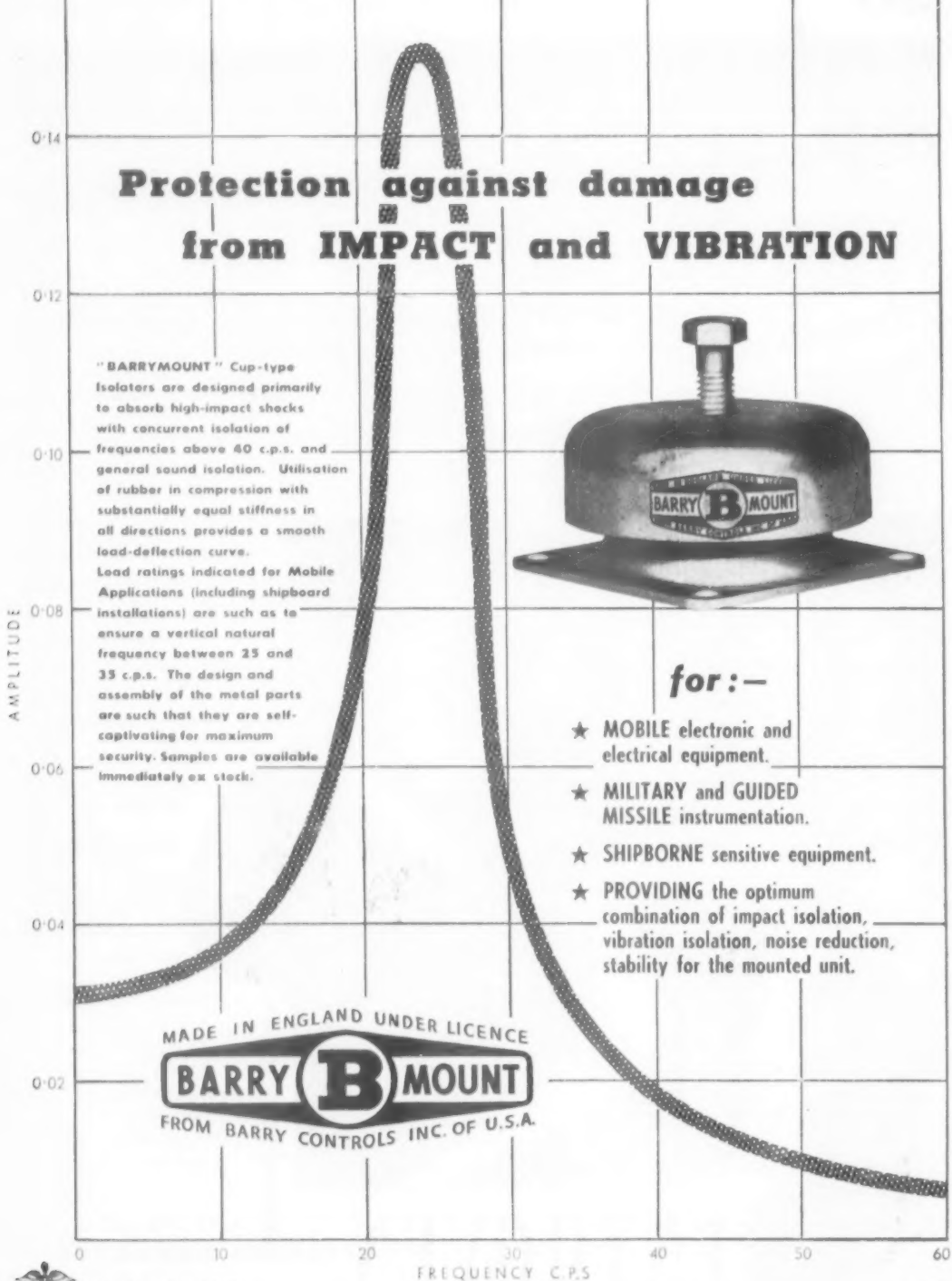

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★ MOBILE electronic and electrical equipment.

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★ PROVIDING the optimum combination of impact isolation, vibration isolation, noise reduction, stability for the mounted unit.

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Cinema-Television Limited announce the first demonstrations of four new instruments which will be given at the above exhibition.

HIGH SPEED OSCILLOSCOPE

Employing a new 5" diameter 'Cintel' tube this oscilloscope is designed for repetitive and single shot pulse examination and has a frequency response extending to 500Mc/s. Sensitivity 50V/inch. Maximum writing speed 50 inches/μsec.

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A high speed chronometer for measuring time in the range 0.125μsec to 1μsec in steps of 0.125μsec. Indication of the measurement is given on seven panel mounted meters in decimal notation.

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Designed to provide uniform contrast contact prints from variable density negatives without loss of information.

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A multi-purpose instrument designed on the well known 'Grid Dip' principle.

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Miniature Multi-channel Recording Equipment.
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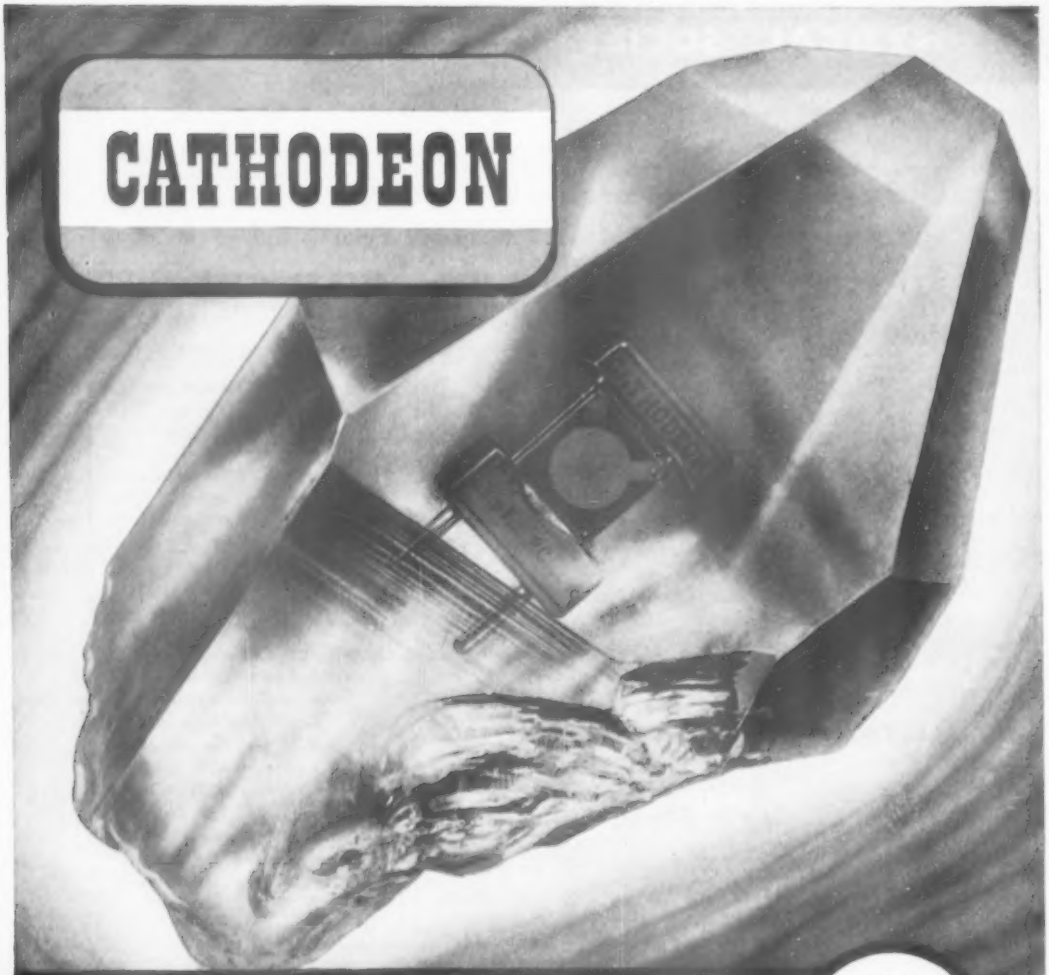

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FOR RELIABLE FREQUENCY CONTROL

Frequency Range, 2,000—20,000 kc/s

Our range now includes crystals for close tolerance requirements

ENQUIRIES ARE INVITED FOR OVERTONES UP TO 60 MC/S.

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FLEXIBLE REMOTE CONTROL OUTFITS

Our experience in the industrial field has indicated that there is a definite need for this type of outfit offering facilities for making prototype flexible remote controls as required.

The two gauges of Remote Control flexible shafts in these outfits cover the range of torque loadings required for • volume controls • all types of wave change switches • condensers • all controls likely to be met in electronic, radio and television equipment.

The outfits are reasonably priced and comprise:

No. 130 (.130 in. dia.) for remote controls up to 4 ft. length..... **£7. 0.0**
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(For use without flexible casing)

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The S. S. White Company will be pleased to advise which Outfit is most suitable for specific applications.

A detailed Parts List is available upon request.

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Precision Relays

An extensive range of standard types always available for prompt delivery

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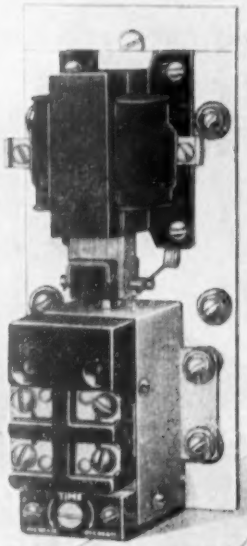

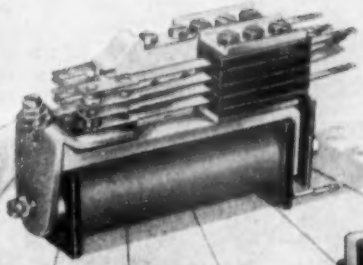

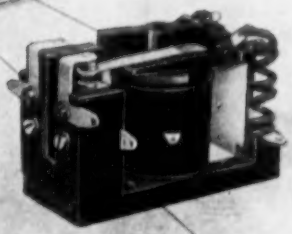

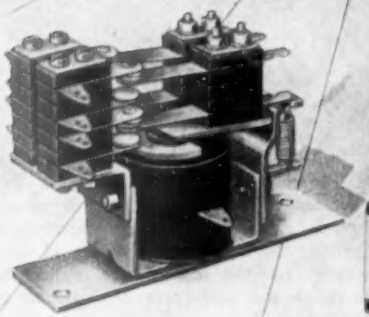

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Now FREE to all!

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Regardless of whether your relay problem is simple or complex, the fact remains that the only reliable solution is that which entirely eliminates risk.

We therefore respectfully invite you to avail yourself of the wide resources of technical knowledge and practical experience possessed by the specialist technicians of our Relay Division.

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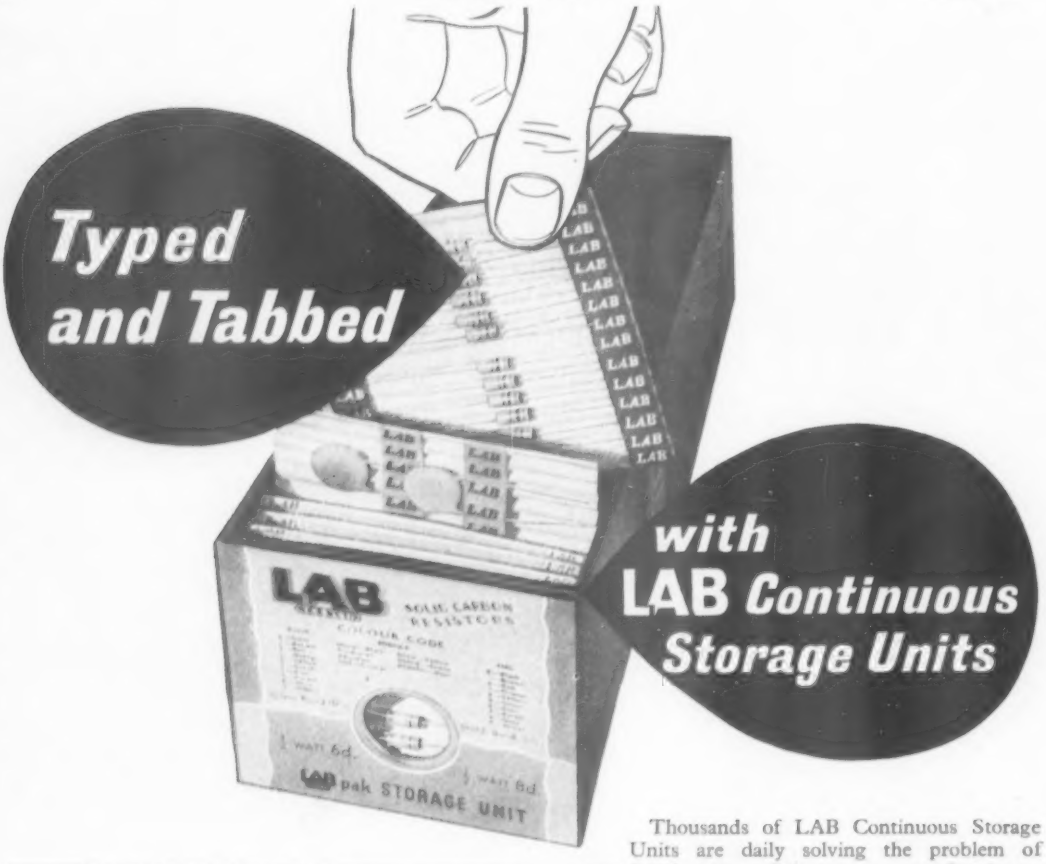

REF.	WATTS	MAX. VOLTS	OHMS	MIN. ORDER FOR FREE UNIT	UNIT STORAGE CAPACITY
RESISTORS					
T	½	250	10 to 10M	240	720
R	1	500	10 to 10M	180	500
Tolerances available ±20% 10% 5%					
HIGH STABILITY RESISTORS					
HS3	½	750	1 to 500M	93	500
Tolerances available ±5% 2% 1%					
WIREWOUND RESISTORS					
LM	5 & 10	—	5 to 100K	72	300
LP	5 & 10	—	5 to 100K	72	300
CERAMICAPS					
CER	Tubular	500	3 to 470pf	141	500
HK	Tubular	500	470 to 5000pf	141	500
HKD	Disc	500	470 to 5000pf	141	500
Tolerances available ±2% 10%					

Thousands of LAB Continuous Storage Units are daily solving the problem of control and storage of the great range of resistors. Compact, and capable of storing up to 720 separate resistors, LABpak make selection positive, simple and speedy. Now that Ceramicaps, Histabs and Wirewound resistors have been added to the carded range the usefulness of LABpak storage units is enhanced.

FREE with any purchase of the LABpak range, these units are the complete answer to the storage problems of small production units, laboratories, etc.

MAKE UP YOUR ORDER TODAY — DELIVERY EX-STOCK

All LABpak resistors are carded in ohmic value, rating and tolerance, colour indexed and tabbed for easy selection.

The LAB Continuous Storage Units are available from your normal source of supply, but more detailed information and literature can be obtained from

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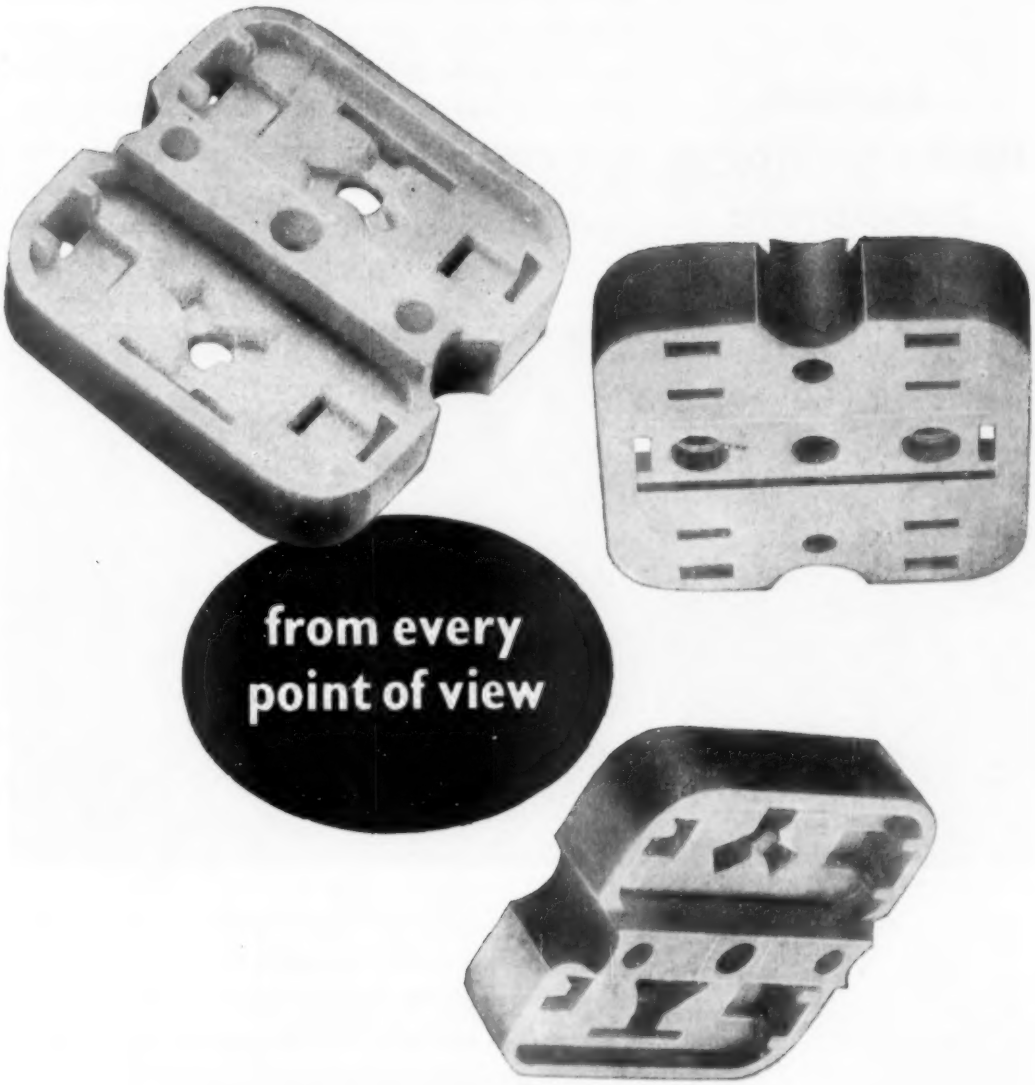

"Frequentite" is the most suitable insulating material for all high frequency applications. Seventeen years ago we introduced the first British-made low-loss ceramic, and consultation with us before finalising the design of new components is a wise precaution.

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S.P.77

for the most uniform response

Of all the different bases that are used for magnetic recording tapes, none can match the precise uniformity of cast cellulose acetate. 'Scotch Boy 111', with its cellulose acetate base, offers recordists the most exact uniformity of response that any tape can provide. 'Scotch Boy 111' is the best of all tapes for high-precision recording, whether of voice, instrument, or mechanical sound.

For laboratory experiments that require the utmost uniformity of response 'Scotch Boy 111' is the natural choice: at 1000 c/s its output variation within each reel is less than ± ¼ db., and the variation from reel to reel is less than ½ db. 'Scotch Boy 111' is used by the services for experiments that involve the precise measurement of mechanical and other sounds, and by sound technicians and expert recordists all over the world.

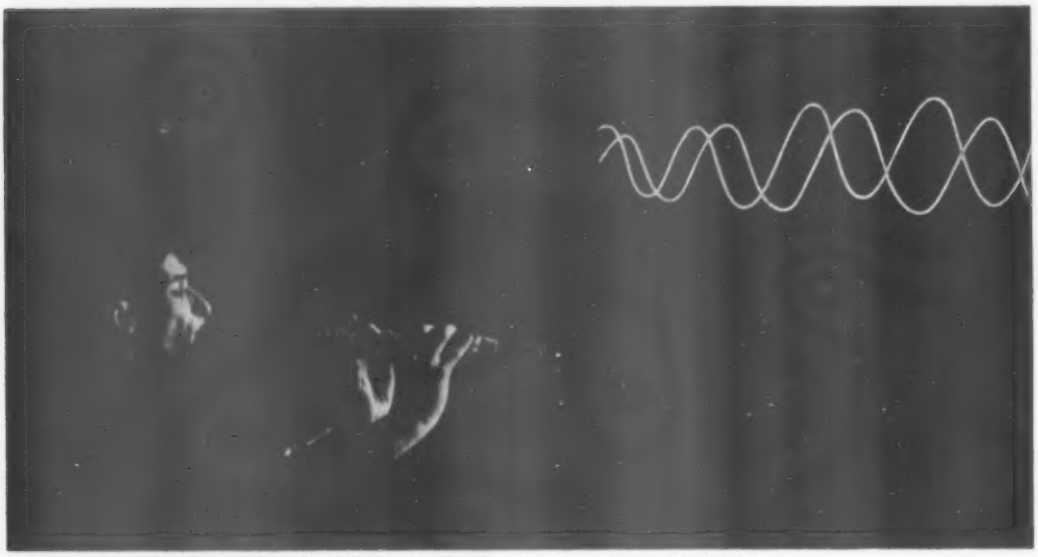

Photo and oscillograph of Cy Laurie playing a characteristically agile embroidery of a phrase from "King of the Zulus".

'Scotch Boy 111' is supplied in 1200-ft. lengths on easily-threaded 7" plastic spools, and also in 600-ft. and 2400-ft. lengths. All these lengths are free from splices.

Record on 'Scotch Boy 111'

—the tape with the cellulose acetate base

'SCOTCH BOY'

Regd. Trade Mark

MAGNETIC RECORDING TAPE

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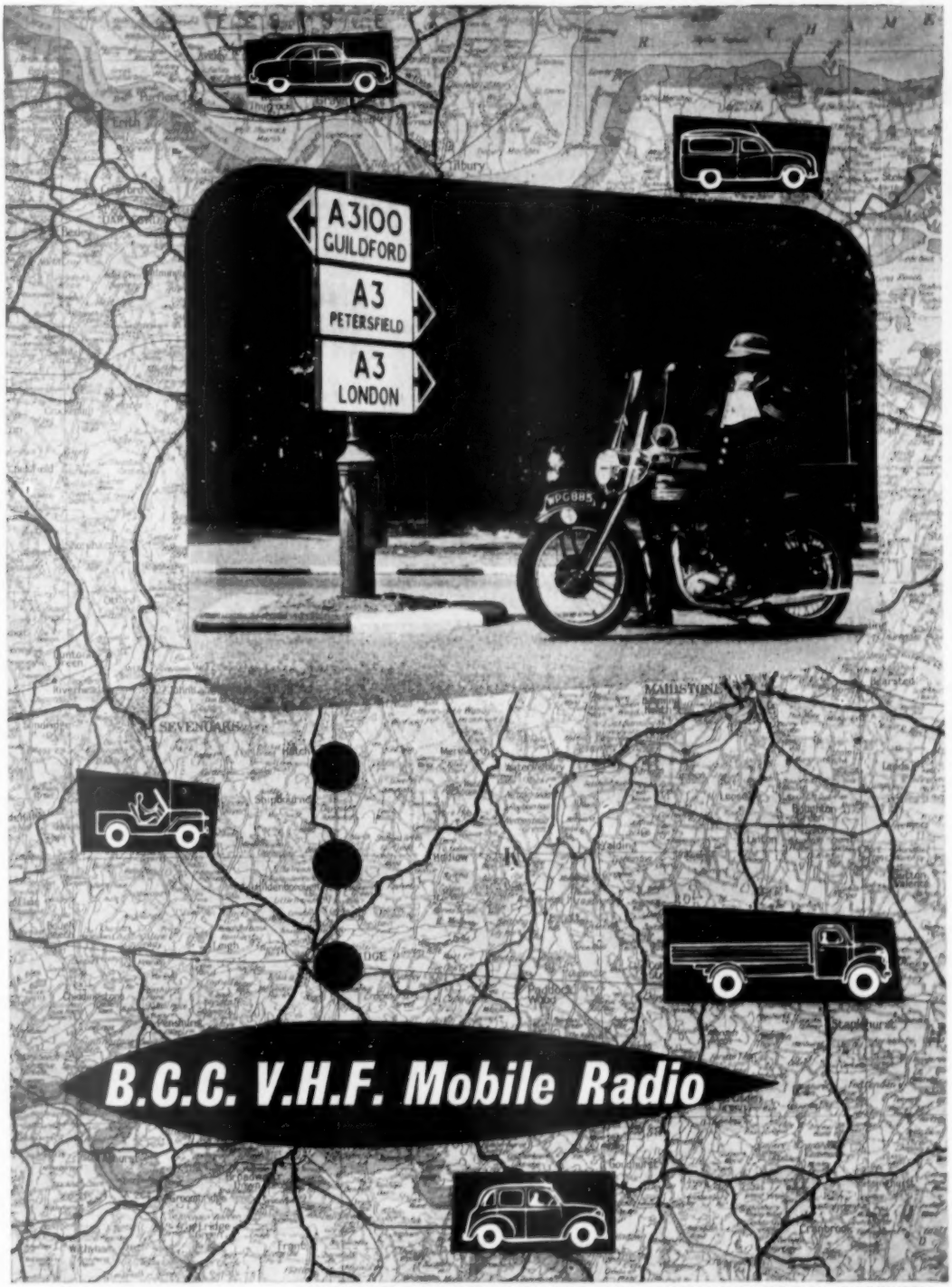

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INSTRUMENTS

X-BAND MICROWAVE WATTMETER — TYPE U.181

A feed-through torque vane wattmeter for absolute measurement of power in the wavelength range 3.05 to 3.45 cms. It will measure power in the range 1 to 100W or the equivalent mean of pulsed power. Accuracy between 100 and 10 watts is ± 2% falling to ± 10% at 1 watt. VSWR better than 0.9.

Price £275 net ex works

R.F. BRIDGE — TYPE B.601 15 Kc/s TO 5 Mc/s

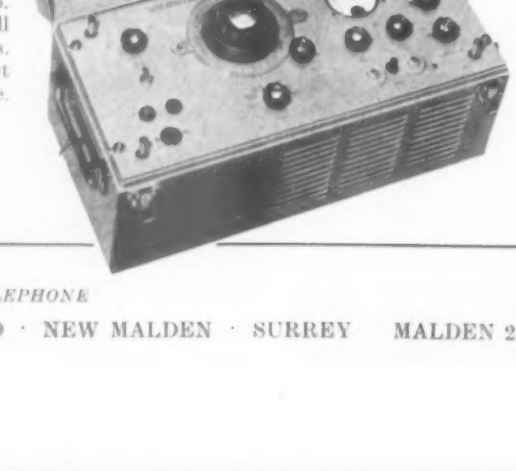
A highly accurate transformer ratio arm bridge for the measurement of capacitance, resistance and inductance within the range 0.01 pF to 0.02 μF, 10Ω to 10 MΩ and 0.5 μH to 50 mH. It can be used to measure complex impedances, balanced or unbalanced, or between any pair of terminals in delta formation.

Price £125 net ex works.

VIDEO OSCILLATOR — TYPE 0.22B

A portable instrument covering the range 10 Kc/s to 10 Mc/s with an output of +10 dbs to —50 dbs on 1 volt p. to p. amplitude stabilised to 0·5 dbs over its full frequency range. It includes a 50 cps. square wave output and facilities for direct reading of the modulus of the load impedance.

Price: Portable £165 net ex works
Rack mounted £158 net ex works.



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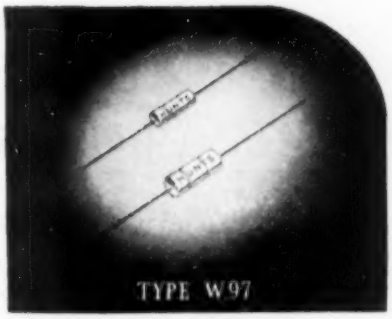
in design— and performance!



HUNTS "THERMETIC" MIDGET METALLISED PAPER CAPACITORS WITH A TRUE HERMETIC SEAL

FULLY APPROVED TO JOINT SERVICES STANDARD R.C.S.136/A CATEGORY 40/100, CLASS H.1.

TEMPERATURE RANGE : — 100°C to + 100°C

The W97 capacitor, although of diminutive size, is an extraordinarily robust unit. Most miniature units are prone to weakness in end connections and general mechanical flimsiness. Such undesirable features are eliminated in the W97 by the special processes used and extreme care in manufacture.

CAPACITOR UNIT
A single metallised paper is used to wind this unit which is made possible by the use of Hunt's Patent covering the "castellated" pattern. Recent development by Hunt on a special impregnating material gives the unit remarkable brackets of operating temperature.

CASING
Hunt's patented double metal tube, sealed with the special "Thermetic" compound, provides positive closure on the casing and lead entry, ensuring positive hermetic sealing.

INSULATION OF CASING
The capacitors are supplied without an insulating medium on the case. If specially requested they can be supplied with an approved plastic sleeve which increases the dimensions by 0.07" in length and 0.03" in diameter.

TERMINATIONS
The terminations are of 24 gauge tinned phosphor bronze wire having a nominal length of 1½". Special attention is paid to the retinning of the wires after the capacitor is fully processed. Connection is made to the unit by applying copper spray to the metallising. The pigtail is soldered to this bond giving a perfect connection of exceptional strength.

INDUCTANCE
W97 "Thermetic" Midgets have a very high self resonant frequency—the following figures are quoted as a guide. 50 pF at 600 volts, which is the lowest capacitance in the range, has a self resonant frequency of 280 megacycles. At the other end of the range, 0.04 μF 200 volts, which is the maximum capacitance, it is 8.5 megacycles.

INSULATION RESISTANCE
This is measured at working voltage at a temperature of 20 C. The minimum capacitance in the range, 50 pF at 600 volts, has an insulation resistance greater than 2,000,000 megohms. The maximum capacitance in the range 0.04 μF at 200 volts, has an insulation resistance greater than 25,000 megohms. The intermediate capacitances are approximately pro rata.

POWER FACTOR
Less than 2% at 1,000 cycles per second at 20 C.

CAPACITANCE TOLERANCE
Standard ± 20%. Closer tolerances are available, for capacitances exceeding 500 pF.

TYPE W97 STANDARD RANGE

LIST NO.	CAP μF.	DIMENSIONS (inches) L.	D.
	200 volts D.C.	Wkg.	
BM7	0.002	0.610	0.135
BM8	0.004	0.610	0.135
BM11	0.004	0.500	0.180
BM9	0.005	0.610	0.135
BM12	0.005	0.500	0.180
BM13	0.01	0.500	0.180
BM14	0.02	0.610	0.180
BM15	0.03	0.610	0.260
BM16	0.04	0.610	0.260
	400 volts D.C.	Wkg.	
BM4	0.0004	0.610	0.135
BM5	0.0005	0.610	0.135
BM6	0.001	0.610	0.135
BM18	0.002	0.500	0.180
BM19	0.003	0.500	0.180
BM20	0.005	0.610	0.180
BM21	0.01	0.610	0.260
	600 volts D.C.	Wkg.	
BM25	50 pF.	0.500	0.180
BM1	0.0001	0.610	0.135
BM26	0.0001	0.500	0.180
BM2	0.0002	0.610	0.135
BM27	0.0002	0.500	0.180
BM28	0.00022	0.500	0.180
BM29	0.00025	0.500	0.180
BM3	0.0003	0.610	0.135
BM30	0.0003	0.500	0.180
BM36	0.0004	0.500	0.180
BM31	0.0005	0.500	0.180
BM32	0.001	0.500	0.180
BM33	0.002	0.610	0.260
BM34	0.003	0.610	0.260
BM35	0.004	0.610	0.260

W97 IS A 'MUST'
for the
MAKERS OF ELECTRONIC EQUIPMENT

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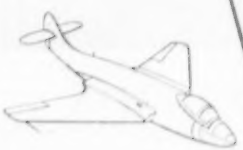
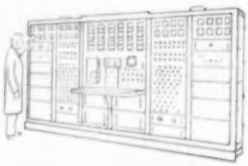
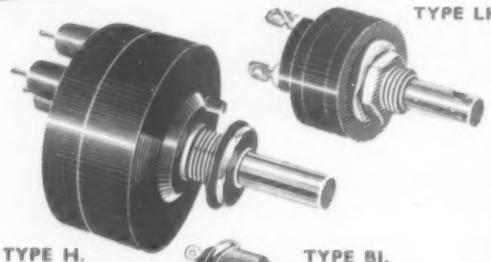
for the Services and all professional equipment applications



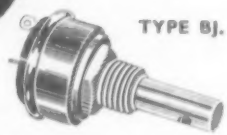


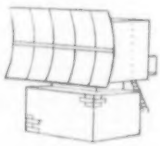
TYPE LH.



TYPE H.

TYPE BJ.





TYPE H. 1½ watts — sealed. The most reliable potentiometer for Services and special requirements. Approved to RCL 122.

TYPE LH. ½ watt — sealed. For special applications. Approved to RCL 122. Can be supplied with or without locating peg ring.

TYPE BJ. 1/10 watt — sealed. Ideal for all miniature applications — used on airborne radar and wherever size and weight are important factors.

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REAL HIGH FIDELITY *at modest cost . . .*

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We are now specialising in the supply of units for making up high-fidelity Radio and Record-reproducing Equipment for use in the Home, small Halls, Schools and Gramophone Societies and single items for replacing in existing equipments and radiograms.
Our Chief Engineer, who is operating a Technical Guidance Service, is available daily, including Saturdays, from 10 a.m. to 6 p.m., or will deal with enquiries by return of post. Our new illustrated Catalogue and Supplement will be a great boon to those desiring high quality equipment for modest expenditure. Send two 2½d. stamps for your copy now. It may well save you Pounds.

No. 1 "SYMPHONY" AMPLIFIER is a 3-channel 5-watt Gram/Radio Amplifier with astonishingly flexible tone control. You can lift the treble, the bass, or—and here is the unique feature—the middle frequencies to suit your own ear characteristics and the record or radio programme being heard. It is thus possible to arrange the frequency-response of the amplifier to a curve equal and opposite to the resultant curve of the other items in the chain so that what finally registers in the brain is as per original. This flexibility of control is even more important than the nominal linear response of the amplifier, as the pickup, speaker, etc., are not linear. Independent Scratch-Cut is also fitted and special negative-feedback circuit employed. The Amplifier can accommodate a wide variety of records from old 78s to new L.P.s. Input is for all types of pickup of 0.1 v. output or more and there is full provision (and power) for Radio Tuner. It is available to match 2/3 or 15 ohms speakers. Price **11 gns.** (carriage 5/-). Fitted in portable Steel Cabinet **2 gns.** extra.

No. 2 "SYMPHONY" AMPLIFIER as No. 1 but with 10-watt Push-pull triode output and triodes throughout. Woden mains and output transformers and choke. Output tapped 3, 7.5 and 15 ohms. Full provision and power for Tuner. Competes with the most expensive amplifiers on the market yet costs only **16 gns.** (carriage 5/-). Fitted in portable Steel Cabinet **2 gns.** extra.

"SYMPHONY" AMPLIFIERS with REMOTE CONTROL. Both the above model Amplifiers are available with all controls on a separate Control Panel with up to 4ft. flexible cable which simply plugs into the amplifier. Enables the Amplifier proper to be sat in the bottom of a cabinet whilst the controls are mounted conveniently higher up. Extra cost **2 gns.**

STUDIO AND DECCA "SYMPHONY" AMPLIFIERS. As above but with built-in pre-stages to precisely match these pickups **2 gns.** extra.

"SYMPHONY" RADIO FEEDER UNITS

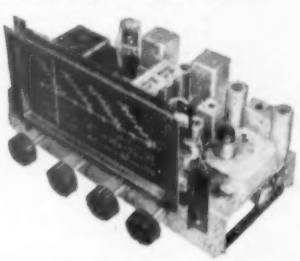
No. 1 "SYMPHONY" T.R.F. TUNER £7/15/-.

No. 2 "SYMPHONY" SUPERHET TUNER £12/2/-.

No. 2 SUPERHET TUNER WITH VARIABLE SELECTIVITY, £14/15/-.

No. 1 "SYMPHONY" FM TUNER. High grade instrument with extremely silent background **£15.8.0.** Power Pack **£3.7.6.**

No. 2 "SYMPHONY" AM/FM TUNER.



Combining all the specifications of the Long, Medium and Short wave Superhet AM Tuner and our No. 1 FM Tuner. Separate Coil Assemblies and I.F.s. Fully self-powered on one chassis. **26 gns.**

N.R.S. EMPRESS FM/VHF TUNER/ADAPTOR. Fine little job, will plug into any radio and add F.M. **£13.15.0.** Magic eye assembly **£1** extra if required. Ditto mounted in beautiful dark walnut cabinet complete with magic eye **16½ gns.** Carriage 7/6.

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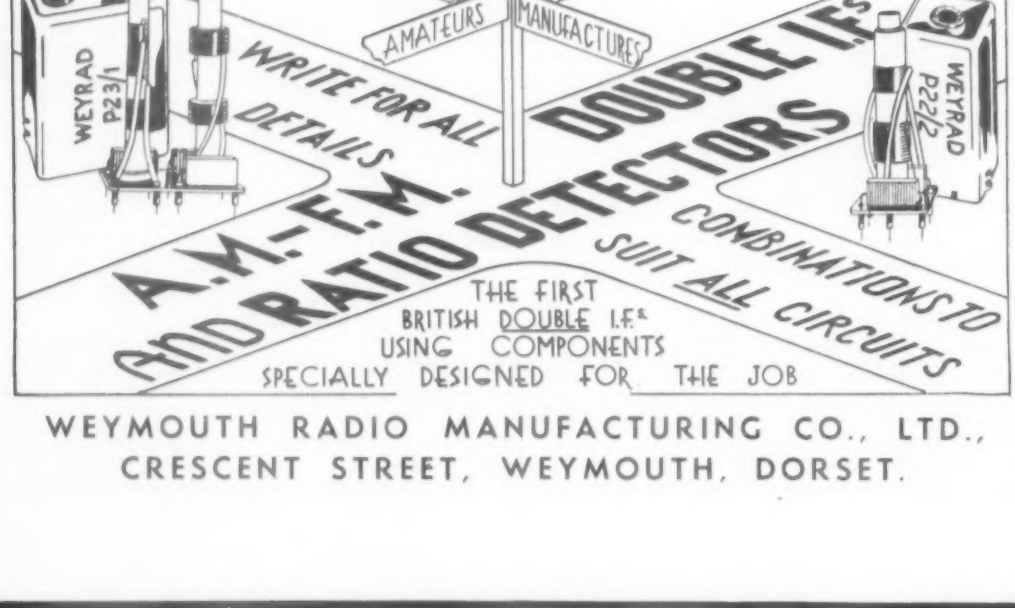

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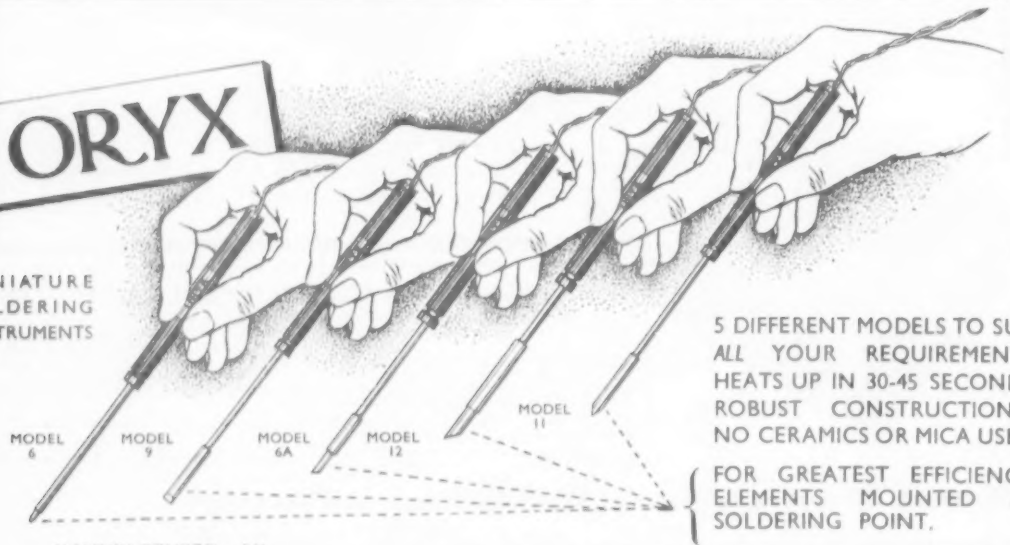

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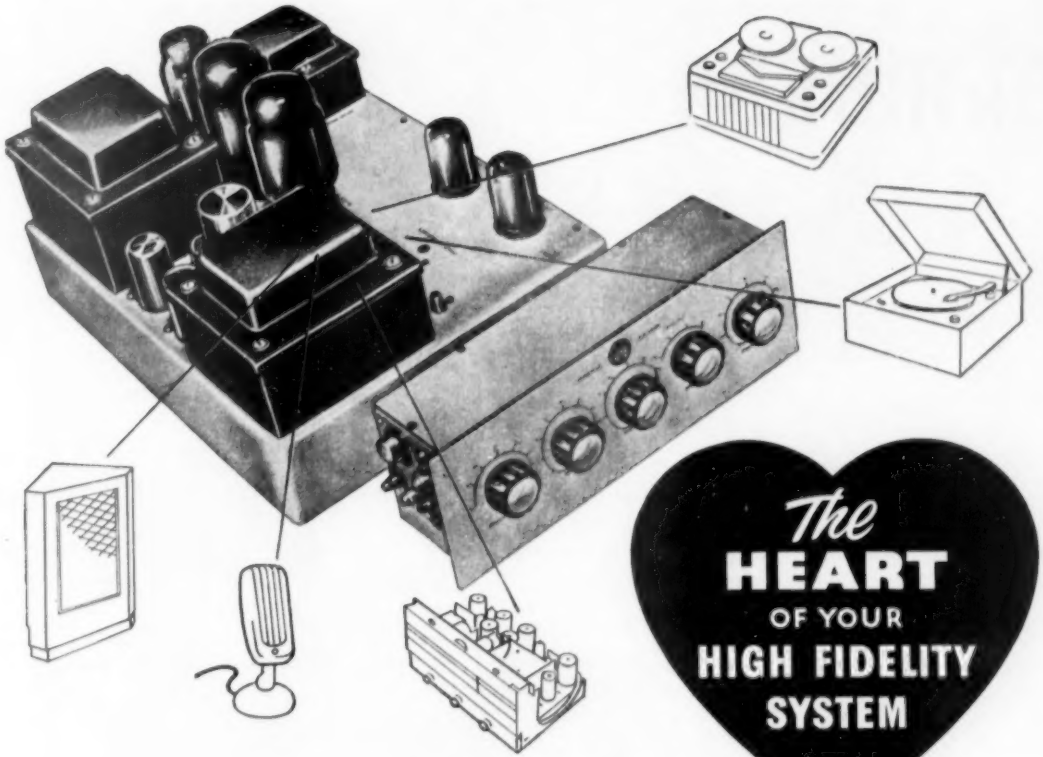
* Model 11—Special High Temperature Model.



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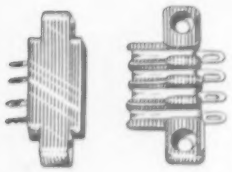

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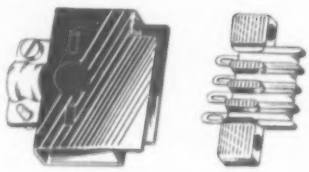

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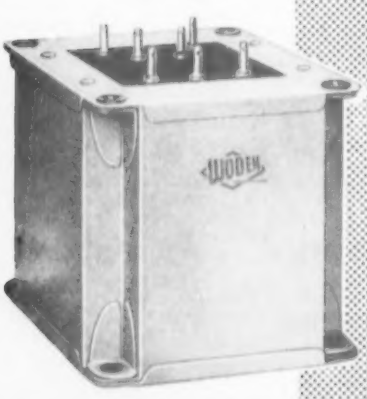

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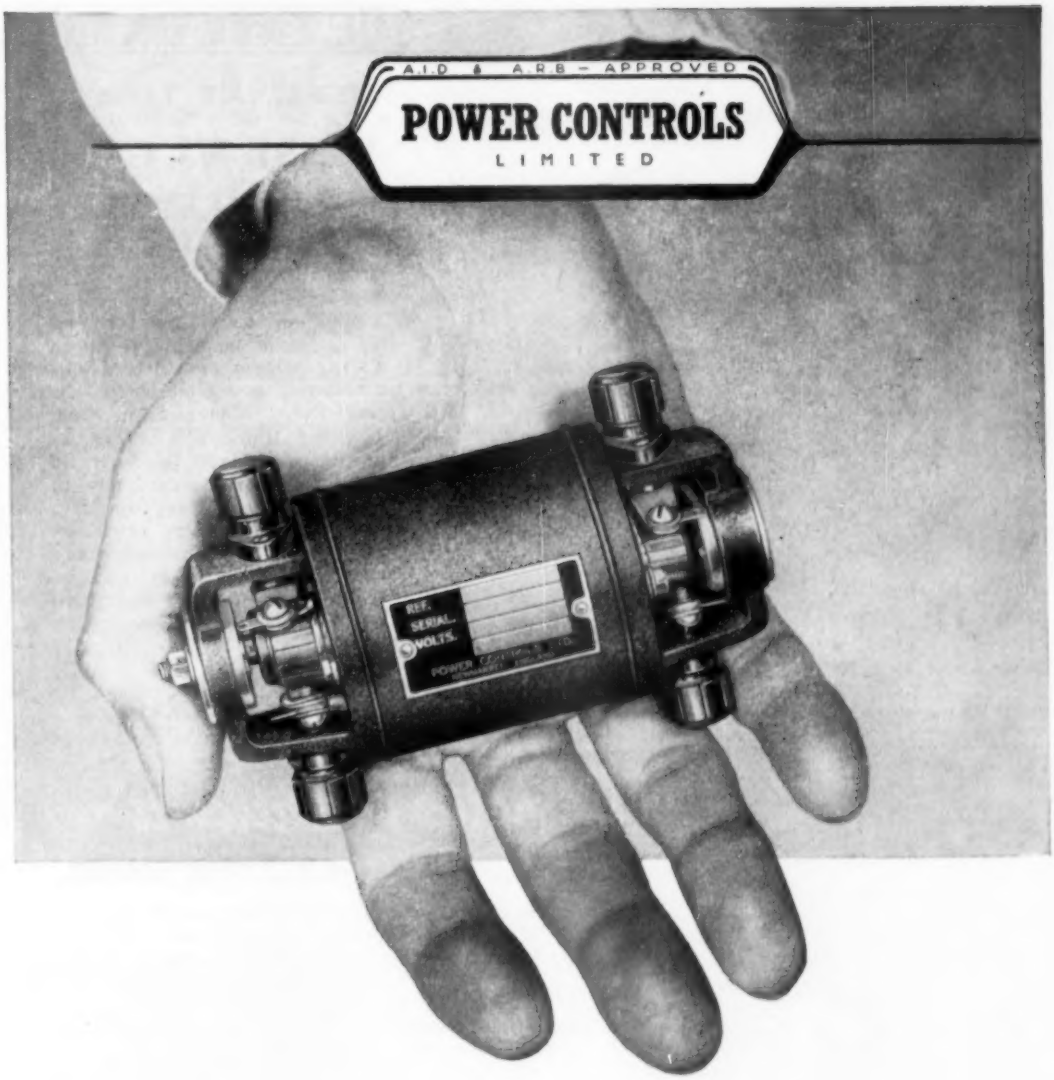

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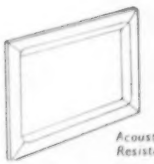

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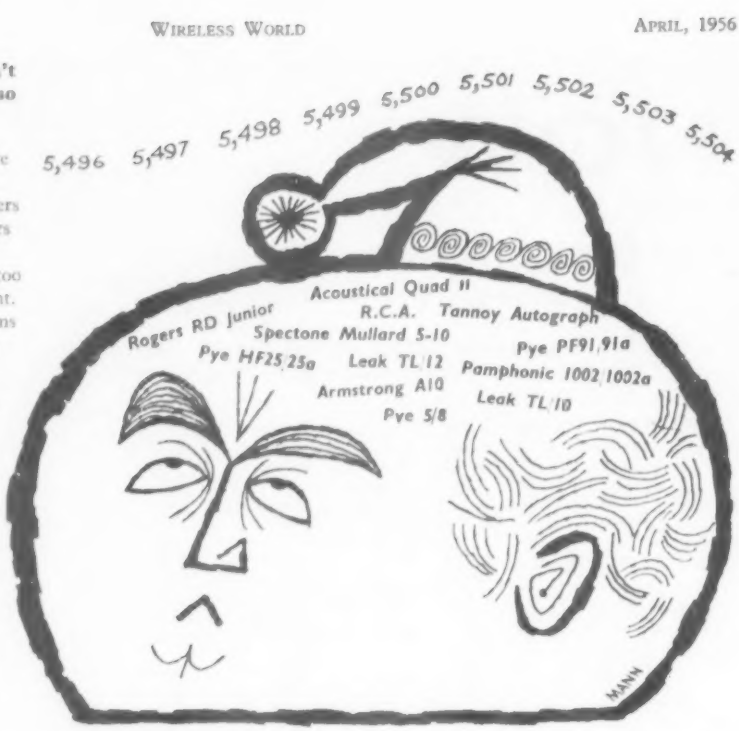

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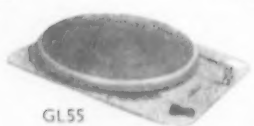

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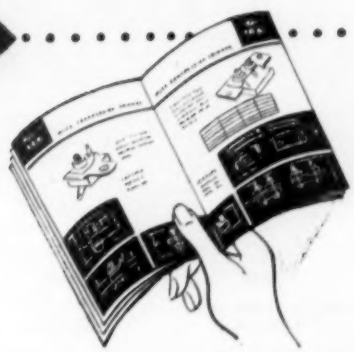

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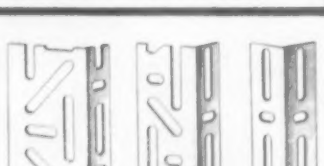

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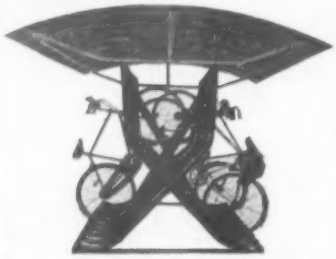

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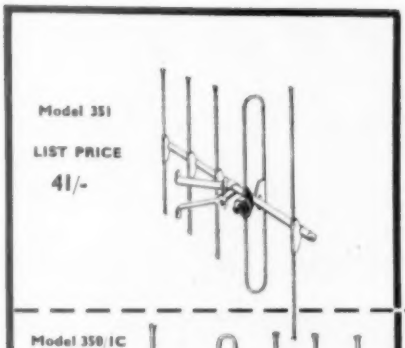

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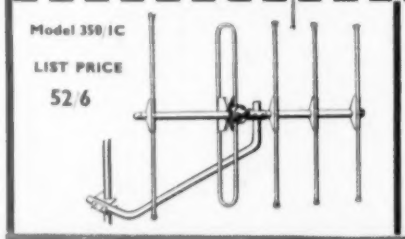

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3 and 5

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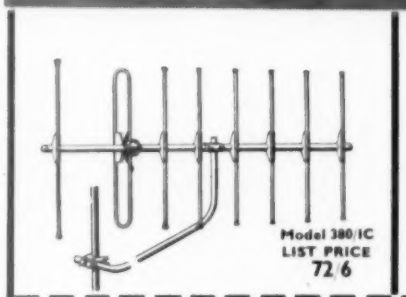

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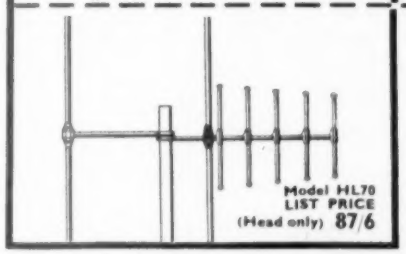
8 and 10



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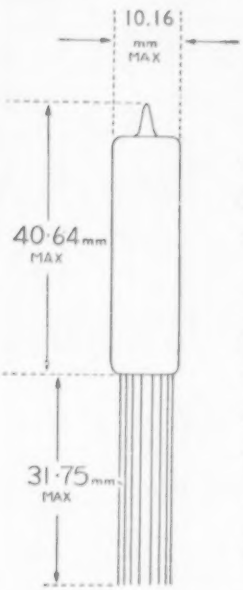

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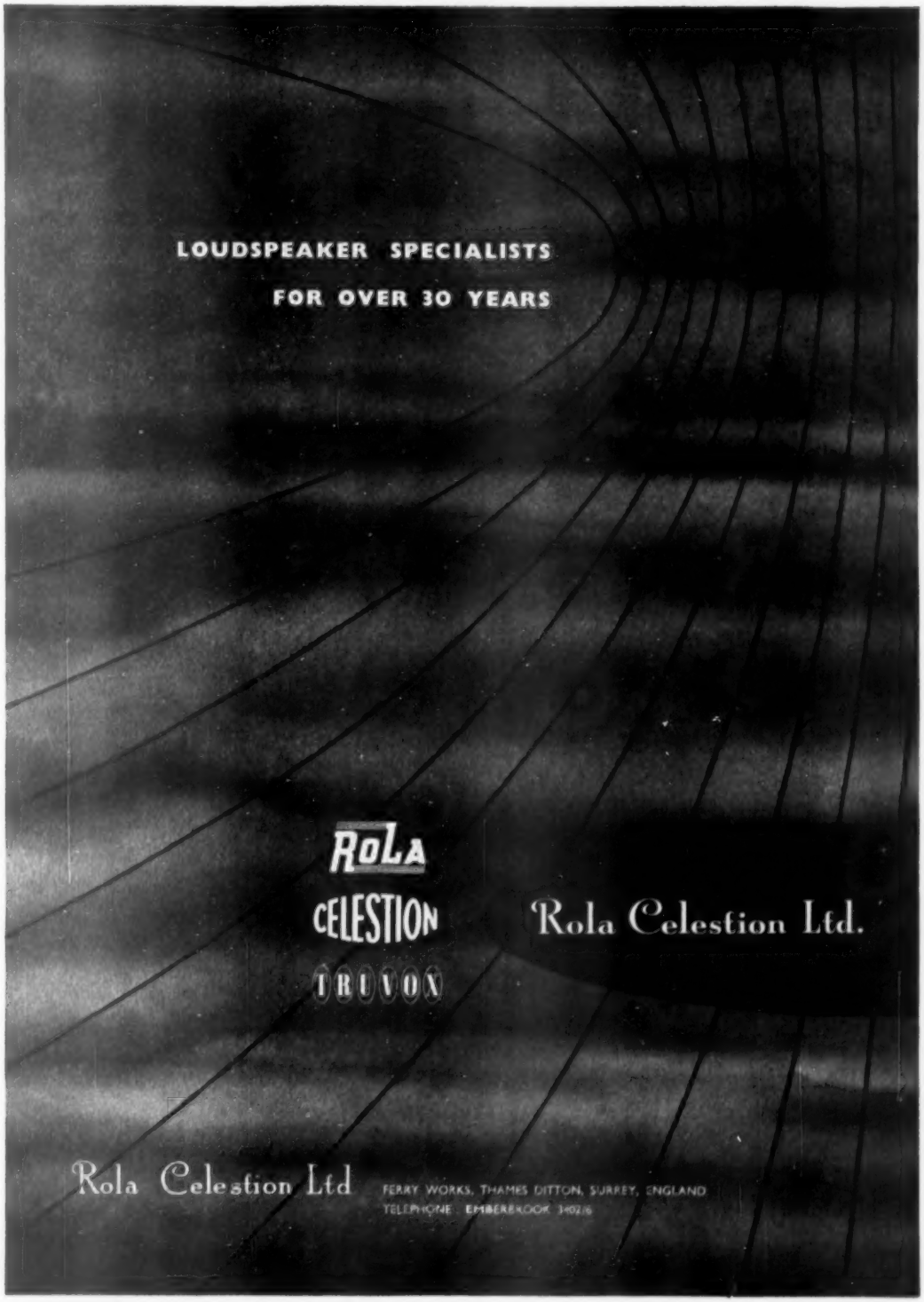
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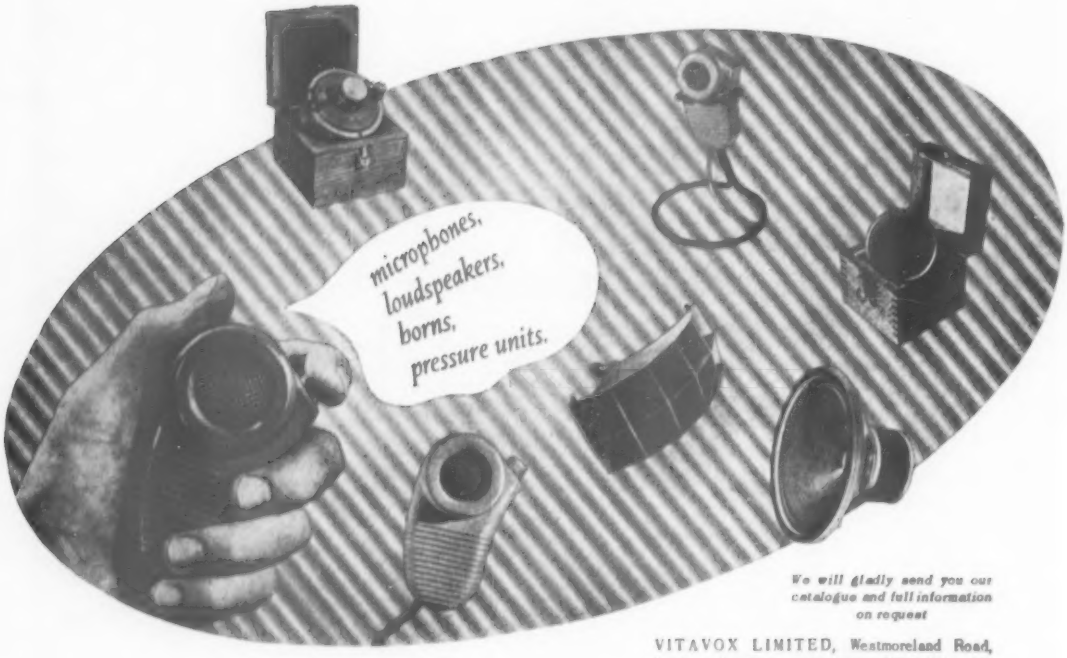

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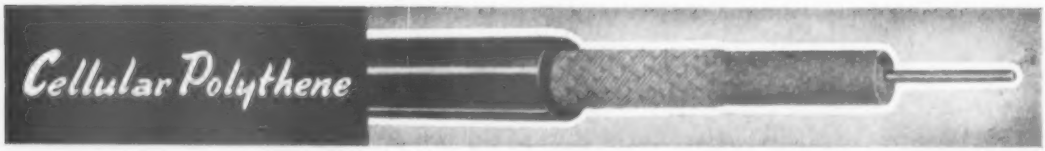

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Diam in inches—					
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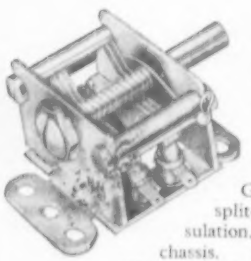

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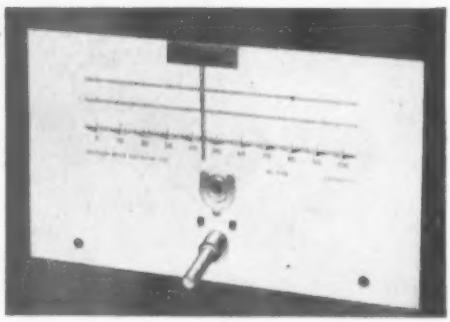

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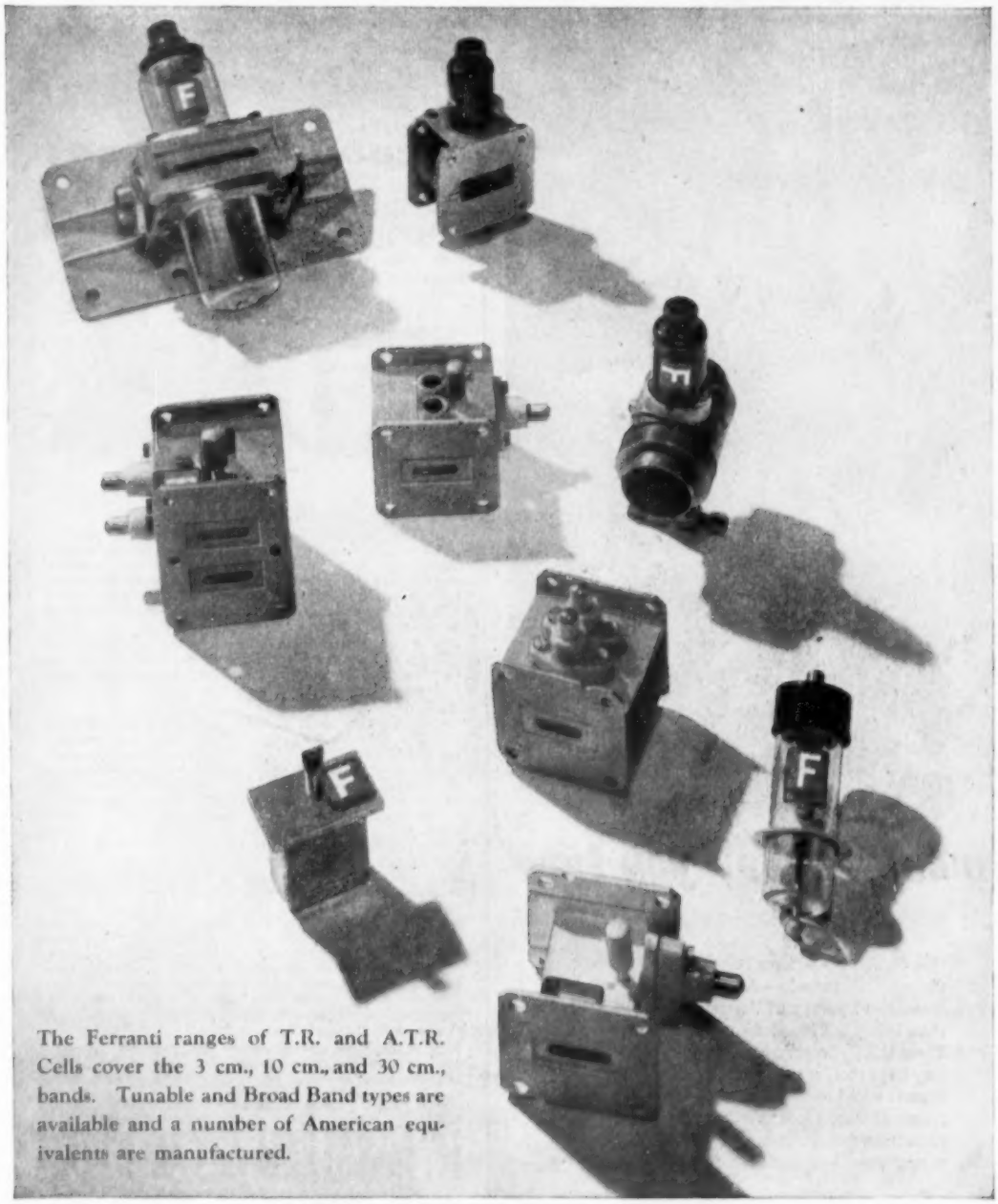

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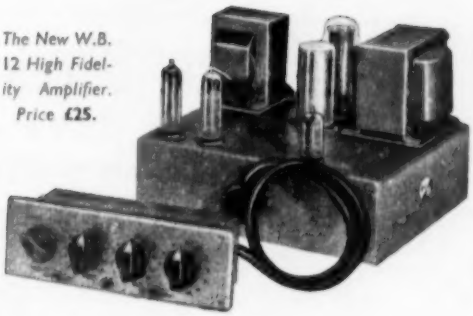
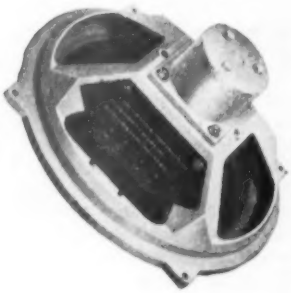


Stentorian High Fidelity 12in. Unit (HF 1214), **£9/15/6.**

THE *Stentorian* RANGE OF HIGH FIDELITY EQUIPMENT



Stentorian High Fidelity 10in. Unit (HF 1012), **£4/19/9.** *Others from* **47/6.**

High Fidelity enthusiasts who have proved for themselves the quality of our products will forgive us if we repeat—for the benefit of those others who have yet to follow suit—that the Stentorian range has demonstrated that true High Fidelity is obtainable at very realistic cost.

The results of 30 years' experience in sound reproduction are embodied in all W.B. lines—in speakers, cabinets and in the amazing W.B.12 Amplifier. The success of our efforts is evidenced by the letters which arrive daily from all parts of the world, echoing the praise given by well-known experts in this country.

Tweeter Units **£4/4/-** *and* **£12/12/-.**

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Hear the remarkable new Stentorian 8" Mid-range and High Frequency Unit, incorporating 16,000 gauss Alcomax magnet. Also 12" Unit (HF 1214) fitted with mid-range stabilisers.

AS EXHIBITED AT THE AUDIO FAIR

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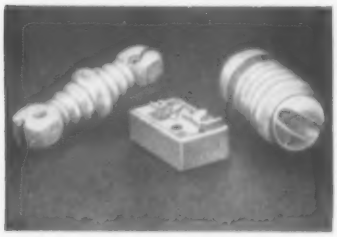

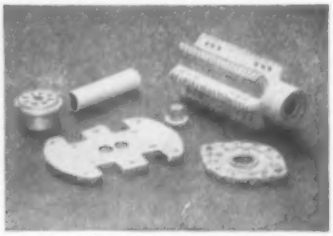

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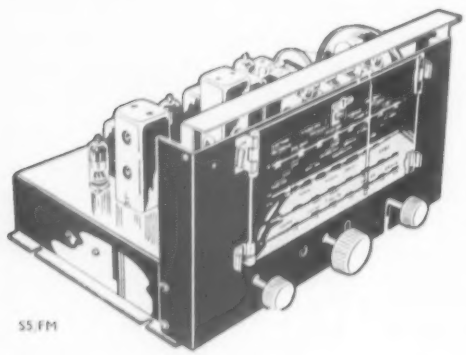

S5.FM

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The combined V.H.F. Frequency and World Wide Amplitude Modulation Tuner uses a tuned R.F., self oscillating additive mixer, 2 x I.F. amplifiers, and Radio Detector on the V.H.F. band II with completely stable tuning. The AM section uses a tuned R.F. stage, F.C., High gain I.F. amplifier with variable selectivity, and delayed Amplified A.V.C. on all wave bands. A Cathode Ray tuning indicator is fitted and operates on all channels and bands. Available in two types.

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S5E/FM 12.5-37 m.; 35-100 m; 90-250 m.; 190-550 m. AM. 87.5-100 mc/s. FM.

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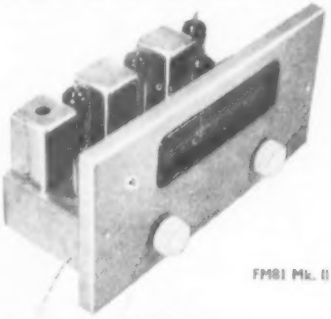

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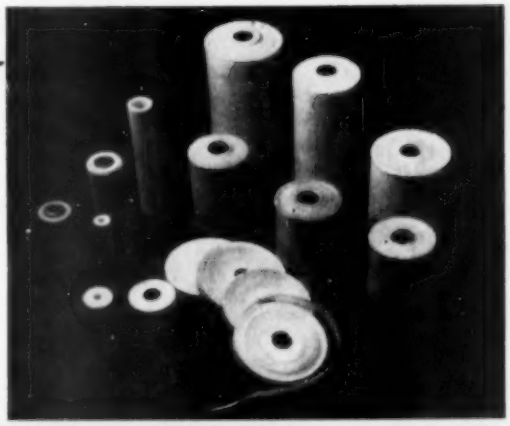

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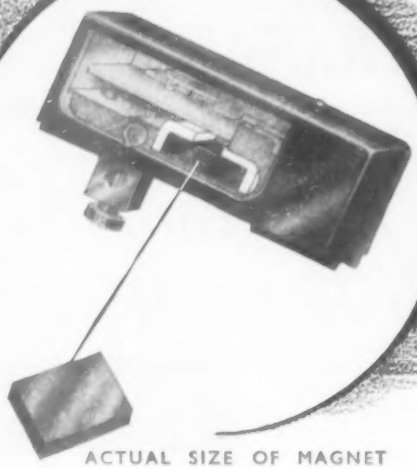

ACTUAL SIZE OF MAGNET

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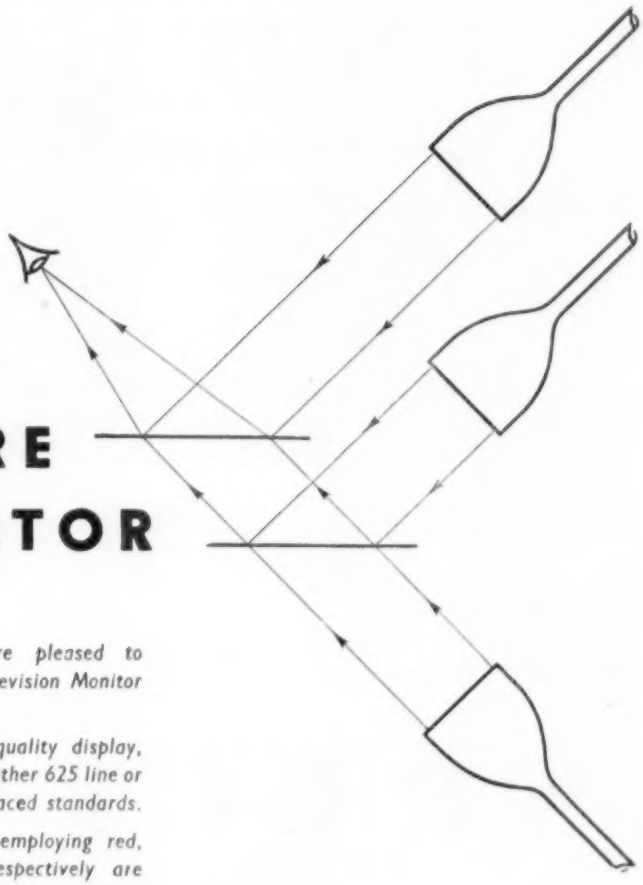

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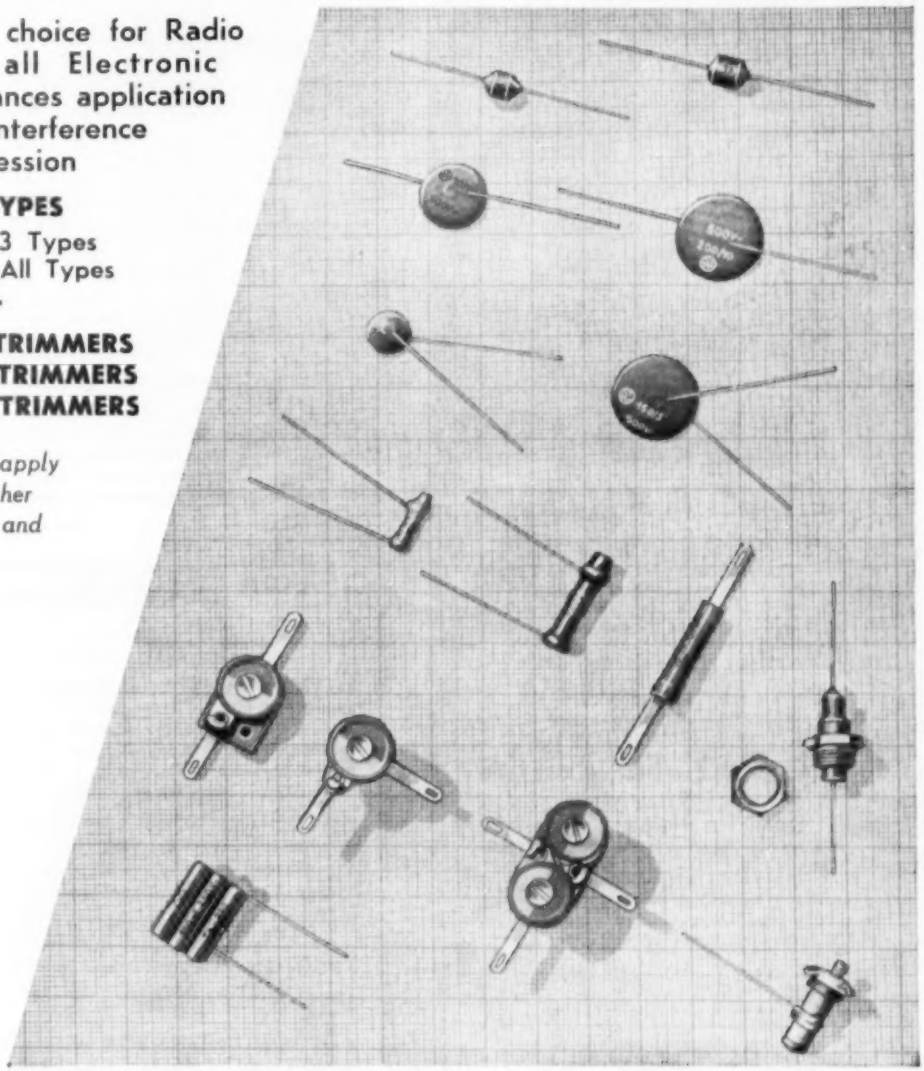

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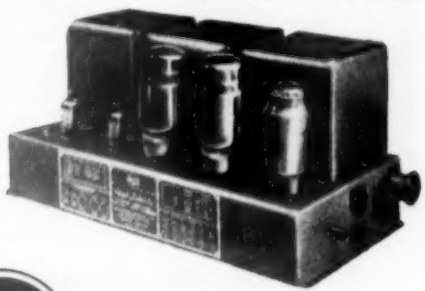

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OUTPUT IMPEDANCES. 4 ohms, 7 ohms, 15 ohms.
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ANCILLARY POWER SUPPLIES. 375 Volts 45 milliamps. 6.3 volts 2.5 amps available for VHF Tuner, Pre-amplifier and Tape Reproducer amplifier.
POWER CONSUMPTION. 130 VA at full load. AC Input 100/150 and 200/250 volts.

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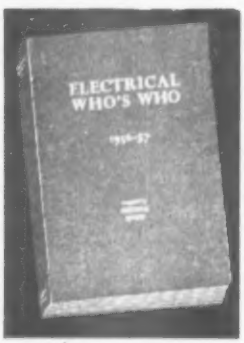

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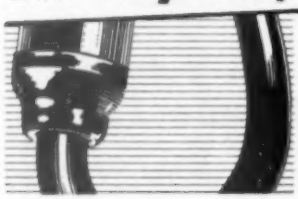

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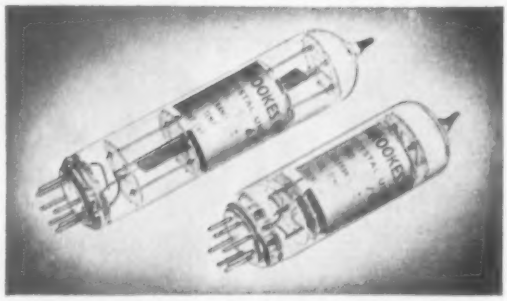

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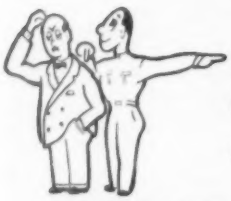

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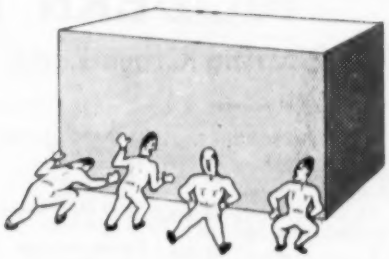

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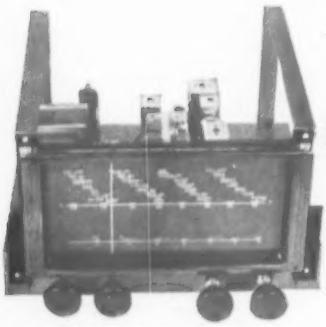

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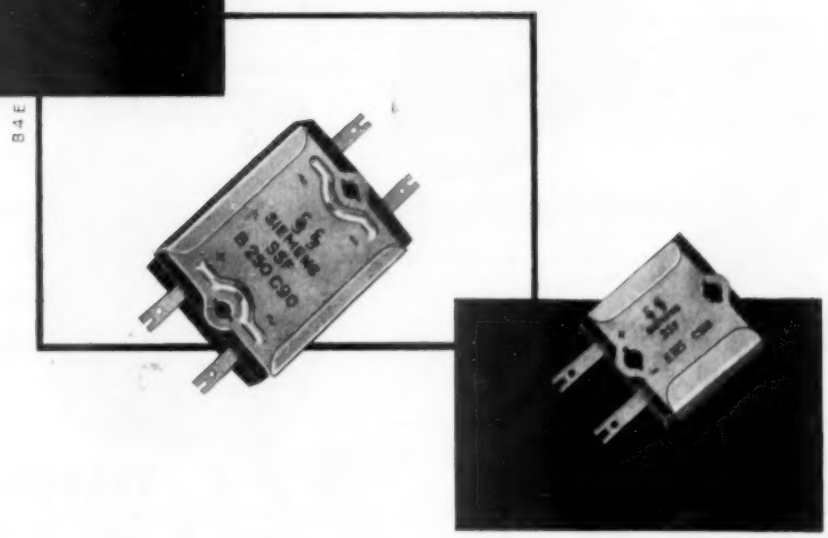

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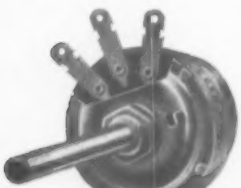

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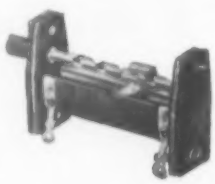

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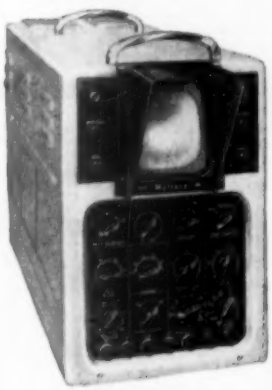

mark 2 features

- **Post Deflection Acceleration** gives a brighter display at low repetition rates.
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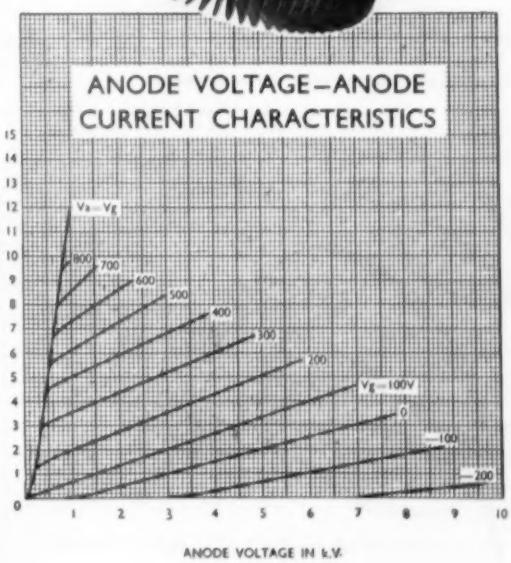
Filament Current (amps)	I_f	26
Maximum Anode Voltage (volts)	V_a (max)	5,500
Maximum Usable Filament Emission (amps)	F_{em}	6
Maximum Anode Dissipation (kW)	W_a	2.5
Mutual Conductance (mA/V)	g_m	*7.5
Amplification Factor	μ	*24
Anode Impedence (ohms)	r_a	*3,200
Maximum Operating Frequency at full rating (Mc/s)		40
R.F. Power Output (kW)		6

* Taken at $V_a = 5{,}000$v; $I_a = 400$ mA.



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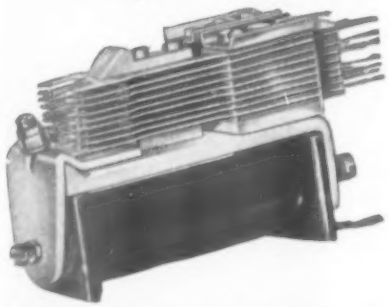

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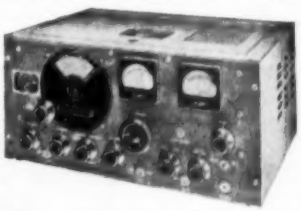

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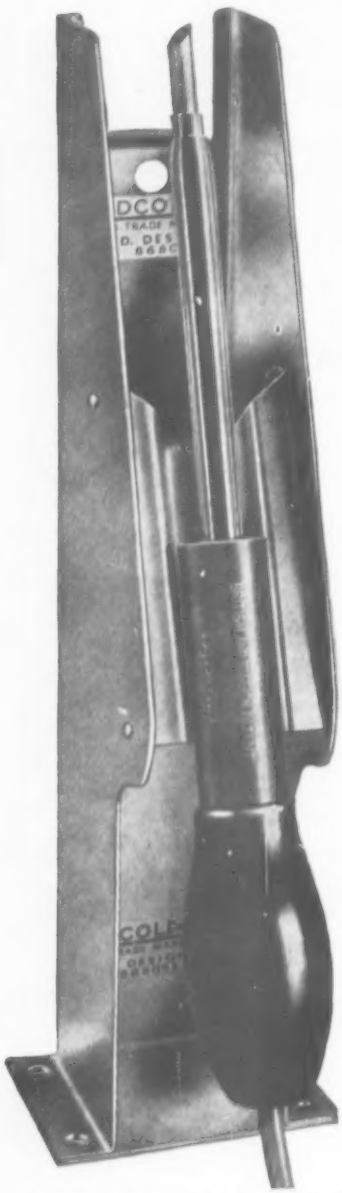

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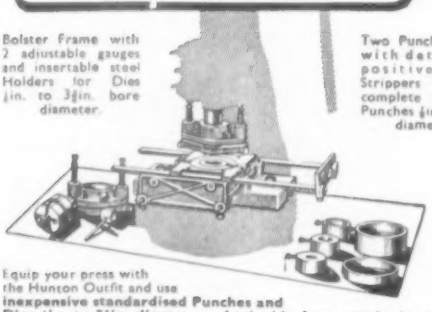

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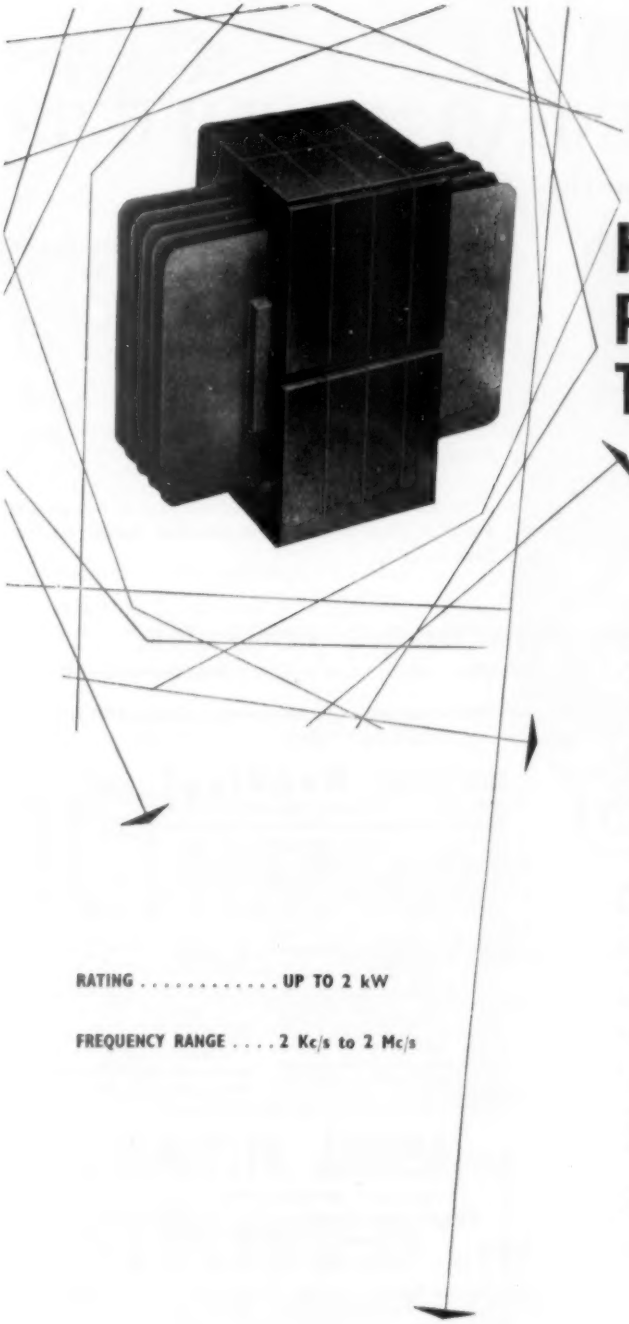

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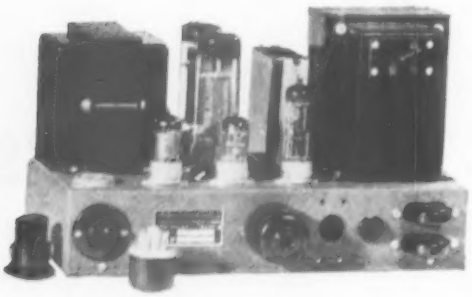

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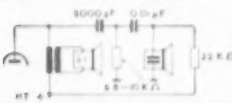

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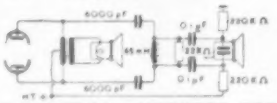

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Full instructional data supplied with each model.

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16 kc/s	=	+ 18dB
18 kc/s	=	+ 13dB
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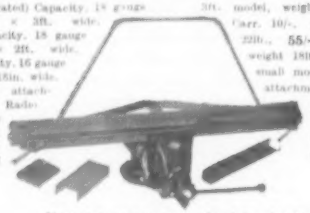

3ft. model, weight 56lb., £4/15/- Carr. 10/-. 2ft. model, weight 22lb., 55/-. 18in. model, weight 18lb., 55/-, carr. on small models 4/-. If with attachments: 5/6.

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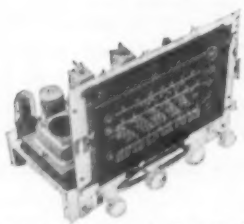

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A 9-valve A.M./F.M. chassis with 4 wavebands (long, medium, short and F.M.), push-pull output stage and magic eye for precision tuning. Specially designed for permeability tuned F.M. stage and a very high degree of I.F. amplification for fringe area reception, it offers the finest quality regardless of price. Automatic volume control and a special wide range tone control. Push-pull output stage and built-in compensated network for electrostatic treble speaker offers an output of 7 watts with the widest possible audio frequency range. Special large 10in. high-flux F.M. speaker with matched treble tone electrostatic speaker, supplied and included with the chassis. Co-axial socket for F.M. dipole aerial. Socket panels for aerial, earth, extension speaker, and gram pick-up. A.C. 200/250 volts, 50 cycles mains. Complete with matched set of knobs and full length edge lit glass dial. Size 15" long, 8½" overall depth, 8" height.

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TYPE A: 5 valves 3 wavebands Superhet with full negative feedback and A.V.C. Full range tone control. **10 Gns.**

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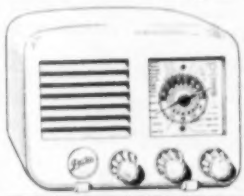

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FIVE Valves superheterodyne, two wavebands (Medium 187-550 metres, Long 1,000-2,000 metres). Universal A.C./D.C. with a high sensitivity and stability factor. Negative feedback and compensated A.V.C. Fixed tone control and pleasing bass response. Housed in attractive cabinet. Packing & Carr. 7/6. **12gns**

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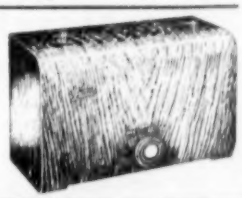

Housed in an attractive cabinet this instrument is designed to enable viewers with single band TV receivers to obtain programmes on Band III transmission (I.T.A.). 200-250 volts A.C. only. Simple to connect. Full instructions enclosed. Only **£9/15/0**

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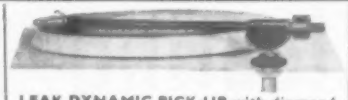

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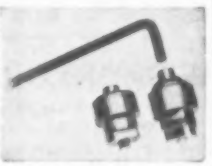

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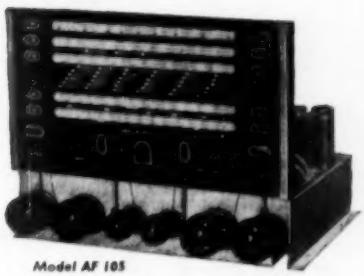

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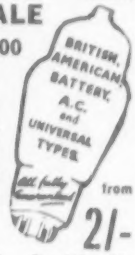

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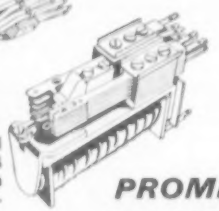

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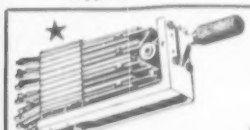

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HARTLEY-TURNER SOUND EQUIPMENT

THE HARTLEY-TURNER "315" LOUDSPEAKER

NOW AVAILABLE WITH EITHER 4 OHMS OR 15 OHMS SPECIAL COIL

The "315" Loudspeaker brings a performance normally associated with far more expensive systems within the range of most pockets. The unique construction gives results that are the closest approach to the "live" performance obtainable at a similar price.

IF YOU WANT HIGH-FIDELITY YOU NEED THE "315"

Specification	
Power Handling Capacity	15 Watts Peak AC
Flux Density	14,000 Gauss
Speech Coil Impedance	4 or 15 ohms (Please state requirements on order)
Fundamental Resonance	27 c/s
Frequency Range	25 c/s—18 Kc/s
Overall Diameter	12.1/8in.
Overall Depth	6¼in.
Nett weight	7 lbs. 8 ozs.
Packed weight	9 lbs. 9 ozs.
Chassis	Die cast non-magnetic alloy

List Price - £10 10 0

H. A. HARTLEY CO. LTD.

66, WOODHILL, WOOLWICH, LONDON, S.E.18.

Phone : Woolwich 2020. Ext. CB32

LABOR W

There is no need to hide your face!

The microphone you've always hoped for is now available.

A good stage presence demands that you are not only heard but seen. You can't put over your act properly if you're half blotted out by the microphone.

We offer you the ideal microphone for audience and artistes:

the almost invisible Studio Microphone MD 3 ST.

The pencil thin rod with the almost invisible halfpenny-size microphone.

- **It does not obscure vision;**
- **Satisfies the most exacting acoustical requirements;**
- **Wide frequency range;**
- **Impedances 50 and 200 ohms;**
- **Reasonably priced;**
- **No extra stand required.**

Note:

If the microphone is to be connected to a high ohm amplifier-input we recommend Miniature Transformer TM 212 which although very small (1in. by ⅜in.) has proved to be a high grade input transformer. It is effectively screened against external magnetic fields. Frequency range up to 20,000 cps. It is easily mounted because of its practical central fastening attachment.

Look out for our next announcements. We will acquaint you with other leading "LABOR-WE" products, as used by B.B.C. and I.T.V.

If you are visiting the Hannover Fair, we shall be pleased to demonstrate our products for you at Stand No 651, Hall 10

We are represented in the U.K. by:

Dimafon Ltd., 27 Craven Street, London W.C.2 (for industrial firms)

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EXPORT ONLY

HALTRON

As leading exporters of Radio Tubes, we have pleasure in giving hereunder our up-to-date stock list which comprises approximately 1,900 types in large quantities.

OA2	1LN5	2T/450E	5BP4	6AS7G	6F7E	6SF5	7E5	12J7GT	25Z6GT	62DDT	260A
OA3	1N3	2V/400A	5BP7	6AT6	6F8G	6SF7	7E6	12K7GT	26J	62TH	262A/B
OA50	1N5G	2X2	5C/100A	6AT7	6F8GT	6SG7	7E7	12K8	27	62VP	264
OA56	1N5GT	2X2A	5C/450A	6AU6	6F11	6SH7	7F7	12K8G	27S	63ME	270A
OA159	1N21B	3A4	5CP1	6AU8	6F12	6SH7GT	7G7	12K8GT	28D7	63SPT	274A
OA160	1N23	3A5	5CP7	6AV6	6F13	6SJ7	7H7	12Q7GT	30	64ME	279A
OA161	1N34(A)	3A8	5D21	6AX4GT	6F16	6SJ7GT	7K7	12SA7	30C1	64SPT	281A
OB2	1N35	3A/167A	5D/100	6B4G	6F33	6SK7	7N7	12SA7GT	30L1	65ME	282A
OB3	1N38(A)	3A/110A	5FP7	6B6	6G6G	6SK7GT	7Q7	12SC7	31	66KU	288
OC3	1N39	3A/141A	5GP1	6B7	6G6GT	6SL7	7R7	12SF7	32	67PT	300B
OC46	1N43	3A/142A	5JP4	6B7G	6H6	6SL7GT	7S7	12SG7	32E	71A	304B
OC66	1N45	3A/144A	5LP1	6B8	6H6G	6SN7GT	7Y7	12SH7	33	72	304H
OD3	1N46	3AP1	5L35	6B8G	6H6GT	6SQ7	7W7	12SJ7	33A/100A	73	304TH
OE3	1N48	3B4	5R4GY	6B8GT	6H8	6SQ7GT	7Y4	12SJ7GT	34	75	304TL
OG3	1N51	3B7	5T4	6BA6	6J4	6SR7	7Z4	12SK7	34E	76	307A
OZ4	1N52	3B24	5U4G	6BA7	6J5	6SS7	8A1	12SK7GT	35A5	77	310
OZ4A	1N54	3B26	5V4G	6BD7	6J5G	6ST7	8A8	12SL7GT	35C5	78	310A
OZ4G	1N55(A)	3B28	5W4	6BE6	6J5GT	6T7G	8D2	12SN7GT	35L6GT	79	310B
1A3	1N60	3B/151A	5W4G	6BE7	6J6	6T8	8D3	12SQ7	35T	80	311
1A5G	1N64	3BP1	5W4GT	6BG6G	6J7	6U4GT	8D5	12SQ7GT	35W4	80/S	311A
1A5GT	1N65	3C4	5X4G	6BH6	6J7G	6U5G	8D6	12SR7	35Z3	81	311BU
1A7G	1N69	3C23	5Y3G	6BJ5	6J7GT	6U5/6G5	9A1	12U5/G	35Z4GT	82	313C
1A7GT	1N72	3C24	5Y3GT	6BJ6	6J8G	6U7G	9BW6	12X3	35Z5GT	83	314A
1AB6	1P1	3C45	5Y4	6BK7	6K6G	6U8	9D2	12Y4	36	83V	323A
1AC6	1P5GT	3C/150E	5Y4G	6BL7	6K6GT	6V4	9D6	13D1	36A	84/6Z4	327A
1AD4	1P10	3C/851A	5Z3	6BM5	6K7	6V6	9HP7	13D2	37	85	328A
1AE4	1P11	3CP1	5Z4	6BQ5	6K7G	6V6G	9NP7	13D3	38	85A1	332A
1AH5	1Q5GT	3D6	5Z4G	6BQ6GT	6K7GT	6V6GT	9U8	13PGA	38E	85A2	332FEN
1AJ4	1R4	3D22	5Z4GT	6BQ7A	6K8	6V6GTY	10	13EPA	39/44	88J	337A
1B3GT	1R5	3D/100A	6A3	6BR7	6K8G	6W2	10Y	13VPA	40	89(Y)	354V
1B24	1S4	3DP1	6A6	6BS7	6K8GT	6W4GT	10D1	14A7	40SUA	90AG	357A
1B26	1S5	3E29	6A7	6BW6	6L5G	6W7G	10F1	14B6	41	90CV	368A(WE)
1B27	1T2	3EP1	6A8	6BW7	6L6	6X2	10LD3	14E7	41E	95	371B
1C1	1T4	3FP7	6A8G	6BX6	6L6G	6X4	11D3	14H7	41MHL	100TH	380A
1C3	1T5GT	3H/354J	6A8GT	6BX6	6L6GA	6X5	11D3	14K7	41MP	117L7GT	388A
1C3	1U4	3LF4	6AB4	6BY7	6L6GT	6X5G	11E2	14R7	41MPT	117N7GT	393A
1C8G	1U5	3LF6	6AB5	6C4	6L7	6X5GT	11E3	14S7	41MTL	117Z3	394A
1C8GT	1X2A	3Q4	6AB7	6C5	6L7G	6X8	12A/112A	15A2	41MXP	117Z6GT	417A(WL)
1CP1	2A3	3Q5G	6AB8	6C5G	6L34	6Y6G	12A6	15A6	41STH	119A	450TL
1D8	2A3/6	3Q5GT	6AC7	6C6GT	6L/D3	6Y7G	12A8GT	15D1	42	121VP	451PT
1D8	2A5	3S4	6AD6G	6C6	6M1	6Z4	12A7	15D2	42E	150B2	610XP
1D8GT	2A6	3V/490A	6AD7G	6C8G	6M6G	6Z5	12A8GT	15E	42MPT	185BT	703A
1D13	2A7	3V4	6AD8	6C10	6M7	6ZY5G	12AH7GT	15R	42SPT	205E	706A
1E4	2B7	4/100BU	6AE8	6C21	6N5	7A2	12AH8	15Y3	43	205F	706A/B
1E7G	2C21	4B31	6AF6G	6C26	6N7	7A3	12AJ8	16A5	43IU	210DDT	707A/B
1E7GT	2C22	4C27	6AF7G	6CD6G	6N7G	7A4	12AL5	17Z3	45	210HF	708A
1F1	2C26(A)	4C29	6AG6	6CD7	6N7GT	7A5	12AQ5	19AQ5	45 Spec.	210HL	709A
1F2	2C34	4C34	6AG6G	6CH6	6N8	7A6	12AT6	19BG6G	46	210LF	713A
1F3	2C40	4D1	6AG7	6CJ6	6P7G	7A7	12AT7	19E2	47	210VPT	714AY
1F5G	2D4A	4EP1	6AH6	6CK6	6P8	7A8	12AU6	19T8	50B5	211	715
1FD1	2D21	4E27	6AJ5	6CK8	6P9	7AM7	12AU7	19X3	50C5	212E	715A
1FD9	2E22	4J53	6AJ7	6CQ6	6P25	7B5	12AV6	19Y3	50CD6G	215P	715B
1G4GT	2E30	4THA	6AJ8	6CS6	6P26	7B6	12AX7	20CV	50L6GT	215SG	715C
1G6G	2G21	4TPB	6AK5	6D1	6P28	7B7	12B7	20D2	50Y6GT	217C	717A
1G6GT	2J21A	4XP	6AK8	6D2	6Q7	7B8	12BA6	20D3	53	220B	721A
1G6GT	2J26	5AP1	6AK7	6D6	6Q7G	7BP7	12BA7	21A6	53A	220SC	723A/B
1H5G	2J31	5A/102A	6AK8	6D7	6Q7GT	7C4	12BE6	23D	53KU	220TH	724A/B
1H5GT	2J32	5A/102D	6AL5	6E5	6R7	7C5	12BH7	24G	54KU	230XP	725A
1H6G	2J34	5A6	6AM5	6E6	6R7G	7C6	12BK5	25A6G	54(HK)	231D	726A
1J5G	2J36	5AZ4	6AM6	6E8G	6R7GT	7C7	12BT6	25L6	57	232BC	731A
1K5G	2J39	4B4G	6AN7	6F5	6S7	7D3	12BY7	25L6G	57S	240TH	800
1K7G	2J48	5B/100A	6AQ4	6F5G	6SA7	7D5	12C8	25L6GT	58	240XP	801
1L4	2J54	5B/250	6AQ5	6F5GT	6SA7GT	7D6	12CS6GT	25SN7GT	58S	241D	801A
1LA4	2K25	5B/254M	6AQ8	6F6	6SB7	7D7	12DP7	25Y5	59	240B	805
1LA6	2N63	5B/502A	6AR5	6F6G	6SC7	7D8	12E1	25Z4G	61BT	242B	803
1LC6	2N64	5B/700A	6AS5	6F6GT	6SC7GT	7D9	12H6	25Z5	61P	249C	805
1LD5	2T/270K	5BP1	6AS6	6F7	6SD7GT	7D10	12J5GT	25Z6G	61SPT	250TH	806

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807	1852	ACR13	CV90	DH81	ECC31	G650	L510	PCL82	RK75	UF42	VT91A
807JAN	1861	ACT6	CV92	DH142	ECC32	GD3	LD010	PCL83	RKR73	UF80	VT93
808	1867	ACT9	CV100	DH147	ECC35	GDT4B	LD410	PD220A	RL18	UF85	VT94
809	1881	ACT17	CV101	DH149	EOC40	GEX00	LL8	PEN4	RL37	UF89	VT96
810	1960	AH221	CV102	DH150	ECC81	GEX34	LL4	PEN84	RM1	UL41	VT98
811	2050	AL2	CV111	DH719	ECC82	GEX35	LN152	PEN85	RM1A	UL84	VT98A
813	2051	AL4	CV118	DK32	ECC83	GEX45/1	LP2	PEN36C	RM2	UM35	VT99
814	2103	AP4	CV117	DK35	ECC84	GEX54/3	LP4	PEN46	RM3	UQ80	VT100B
815	2151	APR4B	CV118	DK40	ECC85	GEX54/4	LP8	PEN220A	RM4	UU5	VT107
816	3220K	APP4C	CV119	DK91	ECC91	GEX54/5	LP35	PEN383	RX233A	UU6	VT108
826	3951	APP4G	CV126	DK92	ECF1	GEX55	L55	PL21	RX235	UU9	VT111
828	4003A	AR7	CV172	DK96	ECF82	GEX56/1	L64A	PL81	S22AF	UY21	VT601
829	4019A	AR10	CV174	DL32	ECH3	GEX66	L6600	PL82	S25A/B	UY41	VT606
829A	4019B	AR11	CV179	DL35	ECH21	GL1	L6D3	PL83	S36	UY85	VT610
829B	4020A	AR12	CV186	DL41	ECH22	GT1B	L6D7	PM2	S27A	UY1N	VU39
830B	4021A	AR13	CV191	DL63	ECH35	GT1C	LZ319	PM2DX	S30A	V30	VU133
832	4022AR	AR300(A)	CV193	DL66	ECH42	GU29	M125H	PM4DX	S130	V286	VU39(A
832A	4033A	AR4101	CV210	DL70	ECH80	GU31	M8162	PM12M	S130P	V345A	VU71
833A	4033L	ARD2	CV222	DL71	ECH81	GU50	MH4	PM22A	SD6	V872	VU72
834	4045A	ARD1	CV239	DL92	ECL80	GZ30	MH41	PM202	SD61	V914	VU113
835	4046A	ARP3	CV240	DL93	ECR30	GZ31	MH4105	POVT23	SG2050	V1120	VU120
836	4049D	ARP4	CV309	DL94	EF8	GZ32	MHL4	PP2	SIMS	V1906	VU120A
837	4052A	ARP9	CV364	DL95	EF9	GZ34	MHLD6	PP3	SP2	V1907	VU133(A)
838	4060A	ARP10	CV415	DL96	EF32	GZ41	MKT4	PP5	SP4	V1924	VU134
841	4061A	ARP13	CV967	DL101	EF36	H2	ML4	PP35	SP13/C	V2022	VU504
843	4062A	ARP34	CV969	DL651	EF37	H30	ML6	PP220	SP22	V6066	VU508
845	4064B	ARP35	CV968	DL510	EF37A	H63	MPT4S	PP220	SP41	VCR35	VX3027
850	4069A	AR86	CV1254	DM70	EF39	H210	MR10	PS5.IE	SP42	VCR97	VX6010
865	4074A	AS05025	CV1479	DM71	EF40	HBC90	MS4B	PT15	SP61	VCR139A	VX7006
866	4075A	AS4100	CV1480	DQ2	EF41	HBC91	MSP4	PX4	SP210	VCR140	VX7066
881	4078A	AT4	CV1481	DQ4	EF42	HD14	MSP41	PX25	ST11	VCR140A	VT2
882	4094A	AT15	CV1487	DRM1B	EF50	HD24	MS/Pen	PY80	STV70/20	VCR263	VT21
883	4205E	AT40	CV1488	DRM2B	EF54	HP93	MS/Pen/B	PY81	STV280/40	VCR511B	W31
884	4212D	ATP4	CV1489	DW2	EF73	HP94	MT9F	PY82	STV280/80	VCR516	W31
885	4212E	ATP7	CV1490	DW3	EF80	HP200	MT9L	PY83	STV280/80	VCR516A	W31
886A	4222B	ATP10	CV1510	DY30	EF82	HP300	MT9M44	PZL/75	GU750	VCR517A	W31
886JR	4228A	ATP78	CV1583	DY86	EF85	HK54	MU12/14	PZ30	5U2150A	VCR517B	W33
889B	4242A	AT825	CV1596	E226	EF86	HK90	MVB/Pen	PZ40	T110	VCR517C	W77
872A	4260A	AT870	CV1856	E4442	EF89	HL2	N14	QA2402	TB1/60	VCR517E	W81
874	4264A	AT8250	CV1873	E1148	EF91	HL4	N15	QA2403	TDD2A	VCR518	W142
878A	4270A	AU5	CV6005	E1156	EF92	HL23	N16	QA2404	TH4B	VCR518A	W143
876	4274A	AU7	CY1	E1190	EF93	HL41	N17	QA2405	TP22	VCR519A	W149
878A	4278A	AZ1	CY2	E1191	EF94	HL80	N18	QA2407	TP4	VCR526	W150
879	4279A	AZ11	CY31	E1192	EF95	HL82	N19	QA2408	TP10	VCR528	W787
884	4282B	AZ21	CY32	E1223	EF804	HP2	N77	QK36	TP11	VCR529	W2232
888	4300A	AZ31	D1	E1228	EH90	HP21	N78	QP21	TP15	VCR530	WD30
902	4304CA	AZ41	D4	E1231	EHT1	HP210	N151	QQV07/40	TP16	VCU " C "	WD142
905A	4304CB	BS1	D15	E1248	EK32	HP4101	N152	QS40	TTR31	VCU " F "	WD150
923	4307A	B30	D41	E1254	EK90	HP4101C	N153	QS70/20	TV02-10	VCU " H "	WD709
931A	4310A	B36	D42	E1265	EL2	HP4105	N154	QS75/20	TV02-12	VCU " P "	WE3A
954	4313C	B65	D63	E1266	EL3	HR2/V	N709	QS75/40	TY1-60	VGT121	WL417A
955	4323A	B152	D77	E1271	EL32	HR210	NC7	QS75/60	TZ20	VGT122	X14
956	4328A	B252	D152	E1272	EL33	HT1	NC8	QS83/2	TZ40	VI 122	X17
957	4328D	B309	D400	E1320	EL34	HVR2A	NC10	QS95/10	U10	VMP40	X18
958A	4337A	B319	DA30	E1322	EL35	HY90	NC11	QS108/40	U12	VP4	X21
960	4357A	B329	DA41	E1336	EL37	HY615	NC12	QS150/15	U14	VP4A	X22
991	4378	B719	DA60	E1342	EL41	IW2	NC18	QS150/40	U15	VP6	X28
1003	4062	BL63	DA90	E1360	EL42	IW3	NC19	QS150/45	U17	VP13D	X34
1201	4660	BM213	DA100	E1366	EL81	IW4	NE16	QV04/7	U18	VP21	X41
1203A	5451	BT45	DAC32	E1370	EL83	KD21	NG7T1	QV06-25	U19	VP23	X56
1221	5457	CBL6	DAF91	E1380	EL84	KD24	NG7T5	QY2/100	U20	VP41	X61
1223	5472	C1C	DAF96	E1415	EL90	KD25	N82	R1	U22	VP74	X61M
1225	5476	C3B	DC51	E1417	EL91	KR1	N85	R2	U23	VR2	X62
1229	5478	C9A	DC96	E1426	EL803	KR3	NT2	R3	U31	VR21	X64
1230	5667	C144	DCC90	E1474	EM4	KR6/3	NT37	R3/16	U32	VR32	X65
1267	5725	CK502	DD4	E1489	EM34	KR82	NT40	R10	U37	VR45	X66
1273	5750	CK546	DD6	E1494	EM35	KT2	NT67T	R13	U41	VR54	X71M
1274	5763	CK549	DD41	E1496	EM80	KT8/C	NT83A	R16	U43	VR57	X77
1282	5823	CK721	DDA1	E1516	EN91	KT24	NT96	R17	U52	VR59	X78
1291	6060	CK723	DDL4	EA50	FQ80	KT30	NT96B	R18	U76	VR65	X79
1294	6397	CK1005C	DDR3	EA76	FRU200	KT31	NT100	R19	U81	VR66A	X81
1299A	7193	CK1006	DDR7	EABC80	ET51	KT32	NU8	RC3	U82	VR66	X143
1381HQ	7475	CL4	DDR25	EAC91	ET96	KT33(C)	NU4	REL21	U83	VR75/30	X150
1603	8011	CL33	DEQ1	EAF42	EY91	KT41	NU5	REL36	U143	VR78	XD2/OV
1611	8012(A)	CMG05	DET3	EB34	EZ4	KT42	OM1	RG1	U147	VR80/30	X01
1612	8013(A)	CS4B	DET5	EB41	EZ35	KT44	OM4	RG1-125	U181	VR91A	YP
1614	8016	CV2	DET9	EB91	EZ40	KT61	OM5	RG1-240	U182	VR102	Y63
1616	8019	CV5	DET10	EBC3	EZ41	KT66	OM5A/B	RG5-250	U184	VR105/30	Z14
1619	8020	CV6	DET12	EBC33	EZ80	KT63	OM6	RG6	U219	VR135	Z19
1620	8022	CV12	DET16	EBC41	EZ90	KT66	OM9	RK30(A)	U800	VR150/20	Z21
1622	8025	CV15	DET18	EBC80	FC2	KT81	OM10	RK35	U709	VS24	Z21M
1624	8025A	CV43	DET19	EBC90	FC4	KTW61	Osglims	RK39	UABC80	VS27	Z40
1625	8026	CV61	DET20	EBC91	FG17	KTW62	P2	RK39A	UAF42	VS110A	Z66
1626	9001	CV62	DET25	EBF2	FG67A	KTW63	P4	RK50	UBC41	VT4C	Z63
1629	9002	CV64	DF33	EBF80	FG67	KTW74M	P27/26C	RK52	UBF80	VT5L1B	Z66
1633	9003	CV67	DF91	EBF81	FG106	KTZ41	P41	RK53	UBL21	VT25	Z77
1635	9004	CV68	DF96	EBF89	FW4/500	KTZ63	P515	RK54	UC92	VT45	Z80
1642	9005	CV82	DF98	EBL1	FX215	KTZ73	P600	RK59	UCC85	VT46	Z142
1646	9006	CV84	DF901	EBL21	G7	L2	PA1	RK67	UCH21	VT48	Z150
1649	AC/PEN	CV87	DF904	EC52	G8	L4	PABC80	RK68A	UCH42	VT48A	Z729
1650	AC/P	CV73	DH30	EC54	G8A	L21	PCC84	RK87	UCH81	VT50A	ZA1
1651	AC4/PEN	CV78	DH63	EC80	G8B	L21DD	PCC85	RK88	UCL11	VT60A	ZD17
1815	ACP4	CV79	DH72	EC90	G75/ID	L30	PCF80	RK89	UF21	VT61A	ZD19
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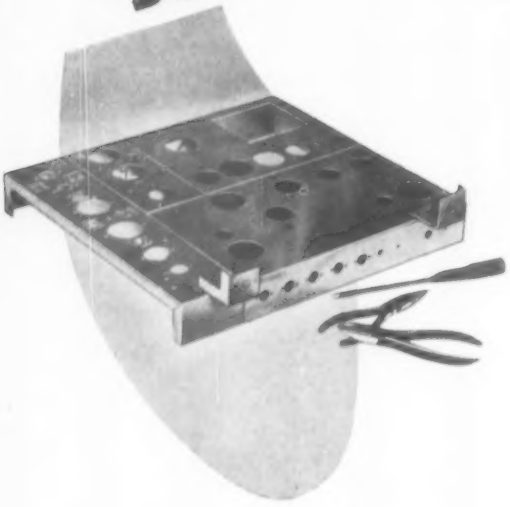

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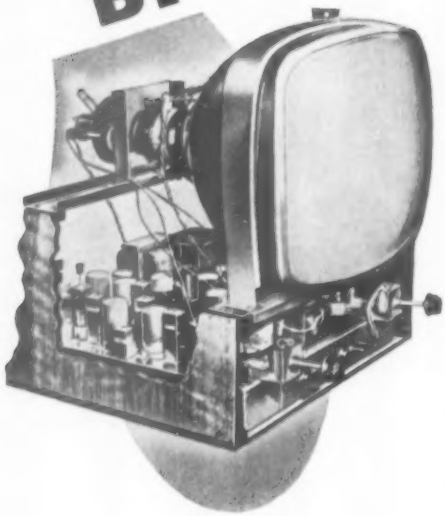

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14 × 9in.	3/2	14 × 7in.	2/11
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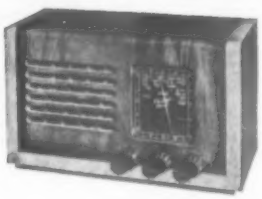

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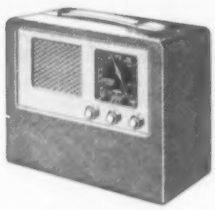

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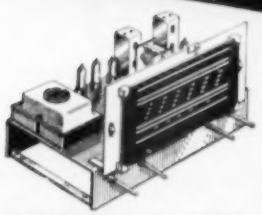

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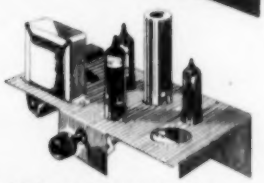

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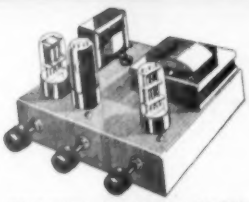

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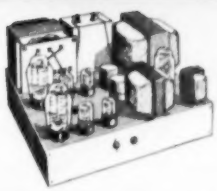

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2 10 watt amplifier...

3 record reproducer

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Wireless World

ELECTRONICS, RADIO, TELEVISION

Managing Editor: HUGH S. POCOCK, M.I.E.E.
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APRIL 1956

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VOLUME 62 NO. 4

PRICE: TWO SHILLINGS

FORTY-SIXTH YEAR OF PUBLICATION

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with supplementary data service

This new Mullard publication provides a quick reference for essential information on Mullard receiving valves and tubes. Data given include typical operating conditions, limiting values and base connections.

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The Mullard Maintenance Manual is obtainable from radio dealers, who can also arrange for the supply of free supplementary data sheets. In case of difficulty, apply direct to Mullard Ltd., Valve Sales Department, Century House, Shaftesbury Avenue, London, W.C.2.

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MVM 346

Wireless World

APRIL
1956

Vol. 62 No. 4

Why 625 Lines?

THERE seems to be a growing belief that colour television for this country should be based on the continental 625-line system rather than on our present standards. This idea was given public expression at the opening of the recent components exhibition, when Sir Robert Renwick, president of the Radio and Electronic Component Manufacturers' Federation, strongly criticized the B.B.C. for spending "vast sums of money" on the development of a colour television system on 405 lines. Sir Robert's advocacy of a 625-line system was based on his belief that "the B.B.C. are developing a system which can only be manufactured for the home market, thus making the cost of manufacturing [receiving] sets for export on 625 lines quite prohibitive." It should be added here that Sir Robert was voicing personal opinions not necessarily endorsed by the radio industry organizations.

Wireless World is not convinced that 625 lines offers any particular advantages—technical, economic or commercial—for colour television. Nobody yet *knows* whether the countries at present committed to that standard for monochrome pictures will ultimately adopt a colour system compatible with it. And, if they do so, a rich export market in receivers will *not* automatically be opened up: experience suggests that most countries sufficiently developed industrially to embark on any kind of television service are likely to be able to assemble their own receivers—perhaps, though, from imported components.

In spite of all that has been written on the subject in this journal and elsewhere there is still a tendency in some quarters to make a fetish of multiplicity of lines. Sometimes it is even thought that a lineage of 625 is, as a matter of simple arithmetic, bound to be about 50 per cent better than 405. So far as monochrome is concerned, this fallacy has been largely dispelled; in relation to colour, the argument is brought up to date in an article on p. 173. Our contributor confines himself mainly to the technical and economic aspects. Broadly speaking, he reaches the conclusion that, just as 625 lines offers no decisive advantages for monochrome, it is even less attractive, in relation to our present standards, for transmissions in colour.

After attending the demonstration of colour television reported on p. 181 we reached the conclusion that lineage was relatively unimportant in comparison with the need for devising a basically cheaper and simpler system. Colour television for Britain—or the Continent—still looks, economically speaking, a long way ahead.

Audio Exhibitions

FOR many years the annual exhibition organized by the British Sound Recording Association has had to turn away potential exhibitors—including many influential firms—for lack of space. The London Audio Fair* held this month found room for most of the big firms in the industry, but was still not big enough for the comfort of the 23,000 people who turned up during the three days of the show. In spite of resourceful and imaginative handling of the crowds there were queues for admission and many demonstrations were fully booked hours in advance. Further expansion both in space and time is clearly indicated.

Both these exhibitions are held in hotels—as are the Audio Fairs in America—and it cannot be denied that an hotel with its numerous rooms and soundproof party walls is ready-made for comparative audio demonstrations. The corridors, too, are carpeted to deaden sound, though they are hardly designed to carry the counter-streams of purposeful enthusiasts in transit from one aural judgment to another.

Anything comparable with Television Avenue at the Radio Show is, of course, impracticable, but we do suggest that a standardized test piece might be made available to all exhibitors, either on tape or disc, to be played on demand for the benefit of those cynics who may think that demonstration pieces are invariably chosen to enhance the merits and obscure the faults of equipment. If the idea is acceptable in principle a sub-committee should be appointed without delay, for 12 months is all too short a time in which to reach agreement on what the test record should contain.

*A report on sound reproducing equipment shown at this and other exhibitions will appear in an early issue.

"Belt-and-Braces" Television Station

FEATURES OF THE NEW LONDON TRANSMITTER AT CRYSTAL PALACE

THE most noticeable thing about the design of the B.B.C.'s new television station at Crystal Palace is the elaborate precautions which have been taken to ensure continuity of service in the event of faults occurring on the equipment. Practically everything is duplicated. As can be seen from Fig. 1, there are two vision transmitters and two sound transmitters and two sets of crystal-drive equipment and video and sound input circuits. Even the aerial is arranged as two independently fed sections (it is actually a temporary aerial but the permanent one will be constructed on the same principle).

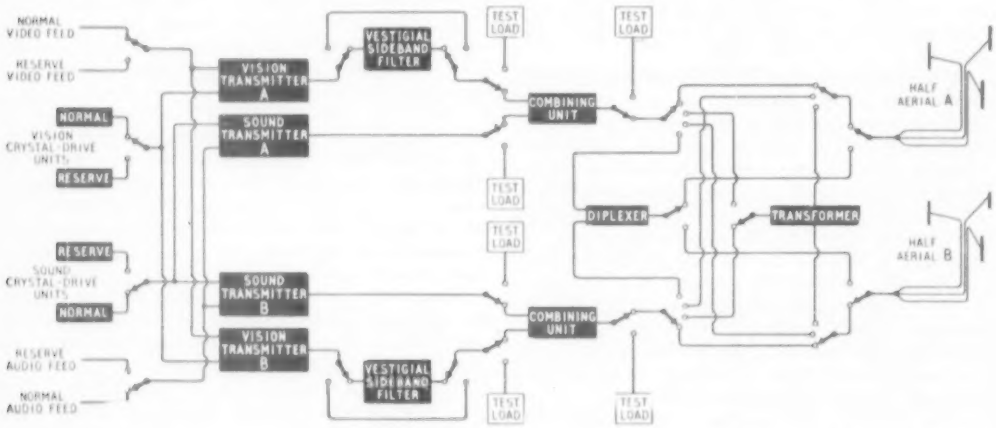
Under normal conditions all four transmitters are working simultaneously. The outputs of vision transmitter A and sound transmitter A are combined and fed to one section of the aerial, while the outputs of vision transmitter B and sound transmitter B are combined and fed to the other section. If there is a breakdown in one half of the system the other half continues operating—but giving, of course, a reduction in output power from the station of 6dB. In addition, however, there is a most elaborate switching system which enables various combinations of the pairs of transmitters and aerial

TECHNICAL DATA ON THE STATION

Vision Equipment (2 transmitters)	
Frequency	45 Mc/s
Output power (each)	15 kW (peak white)
Frequency characteristic ...	vestigial upper sideband
Frequency response	< 1dB down at 2.75 Mc/s
Black level stability	better than ±2%
Sound Equipment (2 transmitters)	
Frequency	41.5 Mc/s
Output power (each)	3.75 kW
Distortion	< 1% at 95% modulation
Present Aerial (temporary)	
Mast height	250ft.
Height of site	360ft. above sea level
Radiators	6 dipoles in two tiers of 3 (at 120° spacing)
Aerial gain	approximately 2:1
Effective radiated power	60 kW (vision), ultimately 200 kW

Our title picture shows a general view of the station with the permanent mast to the right. The building is actually sunk below the ground level of the Upper Terrace and looks on to the Lower Terrace of Crystal Palace.

Below: Fig. 1. Schematic diagram of the duplicate chains of transmitting equipment and switching arrangements.

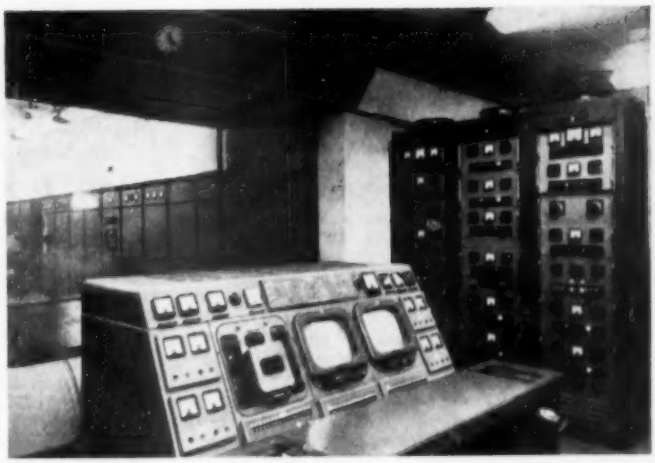


sections to be made. This is brought into action if the fault cannot be cured quickly, the idea being to permit a combination of transmitters and aerial sections that will give an output power reduced by only 3dB instead of 6dB. For example, both pairs of transmitters can be switched to either half of the aerial *via* the diplexer, or one pair of transmitters can feed both halves of the aerial *via* the transformer.

It can be seen that each transmitter has a test load, and this is used to enable any fault to be located and put right under running conditions while the rest of the station continues in operation. Also, the vestigial sideband filters can be short-circuited out if any trouble develops in them.

Incidentally, although both vision transmitters are fed from the same crystal drive unit (and likewise the sound transmitters), this in itself does not ensure that both r.f. outputs will arrive in their respective half-aerials in phase. So to prevent the embarrassing situation of one transmitter "pushing" while the other is "pulling," a phasing system has to be included in the equipment. This consists of a phase comparator working from pick-up points on the output feeders of both vision transmitters, A and B, and manual phase-shift controls in the drive inputs to the transmitters (with a similar arrangement on the sound transmitters). Any phase discepancy between the two is indicated by a centre-zero meter in the phase comparator, and appropriate adjustments are made to the phase-shift controls to correct it.

Apart from the "belt-and-braces" system of operation the station has several other interesting features. It is rather surprising, for example, to find that the vision modulation, which is done at high level on the grids of the push-pull output stage, is achieved entirely with receiving-type valves! Until recently it was only possible to use such small valves for low-level modulation, but the situation has been changed in the Crystal Palace transmitter by the use of high-gain tetrodes for the ouput stage (two CR192s) which do not require a very large input. Previously grid-modulated triodes have been the rule. The higher gain of these tetrode output valves (coupled with the use of other tetrodes throughout the r.f. section) has also made possible a reduction in the number of r.f. stages required, and in fact the whole of the r.f. amplifying equipment is housed in a single cabinet only 2ft 6in wide and 7ft high. For obtaining the necessary bandwidth in the output stage a triple-tuned circuit is used in the anodes of the CR192 valves.

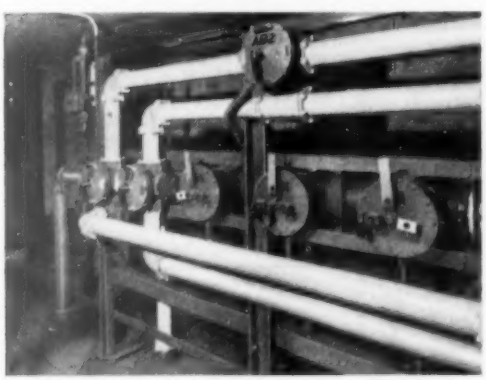


Main control desk, with a view through the window of the transmitter hall. The cubicles on the right contain the crystal-drive and phasing equipment.

The output stage of the modulator actually uses KT67 receiving-type tetrodes in a "shunt-regulated" cathode-follower circuit. The purpose of the shunt regulation system is to maintain the linearity and frequency response of the modulator when it is working into the fluctuating load presented by the CR192 grid circuits of the modulated r.f. amplifier. This load consists of a capacitance and a shunt resistance which varies according to the grid current with different amplitudes of signal.

Another form of regulation in the vision transmitters is for stabilizing the black level of the radiated signal. This is a feedback system working from the transmitter output, and it uses the amplitude of the radiated sync pulses as a measure of black-level variation to apply a correcting signal to the "clamp" circuit which normally sets the black level in the modulator.

All the transmitters, drive equipments, combining units and feeders have been supplied by Marconi's.



Coaxial feeder switching equipment in an upper room of the station. The functions of the coaxial switches here can be seen in Fig 1.

Amateur Colour Transmissions

THIS month British radio amateurs established what is believed to be a record by transmitting colour television signals over a 13-mile path. The colour equipment, built by C. G. Dixon, of Ross-on-Wye, has already been described in *Wireless World*.* For this experiment, Mr. Dixon brought his colour monitor to the amateur receiving station G3CVO/T at Great Baddow, Essex, and left a colour-bar generator and control rack at the transmitting station G2WJ/T at Great Canfield, near Dunmow. The colour-bar generator produced vertical bars in green, black, red, yellow, cyan, blue, magenta and white.

For reception a convertor was used to change the signal from 436Mc/s to 45Mc/s, this output being fed to a 9in television receiver for monochrome work, and into a "Pye strip" 45Mc/s amplifier and thence into the colour monitor. Mr. Dixon's equipment is field sequential, and runs at 150 lines, 100 fields per second, and thus is not compatible. The transmission path was established in monochrome on 405 lines, with two-way sound communication on 145.7Mc/s and 1.98Mc/s, and then switched to colour.

*"Amateur Colour Television," *Wireless World*, April, 1954.

WORLD OF WIRELESS

Organizational, Personal and Industrial Notes and News

National Electronics Show?

THE idea of a large-scale "professional" electronics exhibition covering all aspects of radio and its offshoots—except domestic broadcast receivers—has frequently been advocated by *Wireless World*. It is therefore gratifying to learn from the Radio Communication and Electronic Engineering Association that an Electronic Exhibitions Joint Association Committee has been formed to consider the whole question of national exhibition policy in the industries concerned.

The secretariat of the R.C.E.E.A. (11, Green Street, London, W.1) is acting for the committee on which is also represented British Electrical and Allied Manufacturers' Association, British Radio Valve Manufacturers' Association, Radio and Electronic Component Manufacturers' Federation and Scientific Instrument Manufacturers' Association.

Physical Society Exhibition

ON May 14th the 40th exhibition of scientific instruments and apparatus, organized by the Physical Society, opens at the Royal Horticultural Society's Old and New Halls, Westminster, London, S.W.1. The number of exhibitors (131) is approximately the same as last year but, by utilizing both halls, there will be more space for visitors—a welcome change.

The exhibition opens on the first day at 10.30, but admission is limited to members and the Press until 2.0. On the 15th, 16th and 17th it opens at 10.0. Except on the last day when it closes at 5.0, it will remain open daily until 8.0.

At 6.15 on May 16th, G. G. Gouriet (B.B.C. Research) will give a lecture-demonstration on colour television.

Visitors' tickets are obtainable from the Physical Society, 1, Lowther Gardens, Prince Consort Road, London, S.W.7; a stamped addressed envelope should be enclosed.

B.S.R.A. Show

THERE will be a 60% increase in the number of exhibitors at this year's show of sound recording and reproducing equipment organized by the British Sound Recording Association for May 26th and 27th at the Waldorf Hotel, Aldwych, London, W.C.2. Moreover, 25 of the 38 exhibitors listed below have this year booked individual demonstration rooms instead of sharing a communal demonstration room as has been done in the past.

Acoustical Manufacturing
Ariel Sound
Armstrong
B-K Partners
Beam-Echo
British Ferrograph
Collaro
Cosmocord
C. T. Chapman (Reproducers)
E.M.I.
G.E.C.
Garrard
Goldring
Goodmans
Goodsell
Grundig
Kelly Acoustics
H. J. Leak
Lockwood.
Leevers Rich
Lowther Manufacturing
Lustraphone
Minnesota Mining & Mfg.
M.S.S. Recording
R.C.A. Photophone
Reslosound
Rogers Developments
Rudman Darlington
Simon
Specto
A. R. Sugden
Tannoy
Thermionic Products
Truvox
Vitavox
Wharfedale
Whiteley Electrical
Wireless World

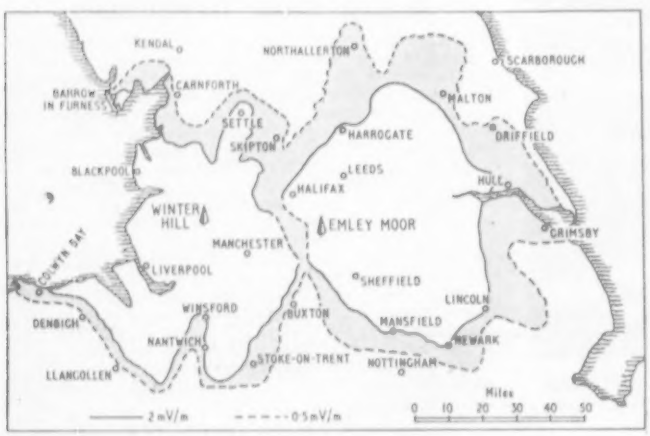
The exhibition, which is the eighth organized by the Association, opens at 10.0 on both days and closes at 6.45 and 6.0, respectively. Admission is by catalogue, price 2/-, obtainable from S. W. Stevens-Stratten, 3, Coombe Gardens, New Malden, Surrey, after May 14th, or at the exhibition.

5,000,000 Components a Day

PRODUCTION of radio and electronic components, which last year rose by 30% compared with 1954, has doubled during the past four years and is now seven to eight times the pre-war level. Five million components are now made every working day, according to 23rd annual report of the Radio and Electronic Component Manufacturers' Federation.

Exports, including components for sound reproduction equipment, were valued at £13.4M in 1955, an increase of nearly 23% on the previous year. The United States is now the principal British market for high-quality sound reproduction equipment and India the largest purchaser of components.

The report points out that while



THE FIRST of the I.T.A.'s northern transmitters—at Winter Hill, Lancs. (channel 9)—opens on May 3rd. The anticipated overall coverage in the northern region when the second station—on Emley Moor, Yorks. (channel 10)—opens in the autumn, is shown on this map.

the sound and television receiver industry remains the principal single consumer of components (amounting to 48.5% in quantity and 42.2% in value) there is a rising demand in all sections of the industries served. Radio communications and radar gear take 14.8% of the output of component manufacturers, telecommunications gear 5%, sound reproduction equipment 4.4% and defence, instrumentation and industrial electronics, etc., 8.8%. The remaining 18.5% is exported.

PERSONALITIES

S. M. Aisenstein, a pioneer of wireless and one of the world's foremost valve designers, has retired from the position of general manager of the English Electric Valve Company, which he has held since the company was formed in 1947. He is being retained as a consultant on vacuum physics by the English Electric Group. A native of Kiev, he formed a wireless company in Russia in 1907 and at Guglielmo Marconi's invitation came to England in 1908. Three years later the Russian company, with Mr. Aisenstein as director and principal technical adviser, coalesced with the Marconi Company. In 1922 he was appointed to a company established by Marconi's in Poland and three years later went to Czechoslovakia, where he set up a valve manufacturing company. For some years prior to the formation of the English Electric Valve Company he was in charge of the Marconi valve laboratories at Chelmsford.

Dennis Gabor, Dr. Ing., M.I.E.E., F.Inst.P., Mullard Reader in Electronics at the Imperial College of Science and Technology, London, has been elected a Fellow of the Royal Society "for his work on transient electric phenomena, electron microscopy, the theory of communication and the electric arc plasma." Dr. Gabor was born in Hungary, studied in Budapest and at the Technische Hochschule, Berlin-Charlottenburg. His thesis, in 1927, was on one of the first high-speed cathode-ray oscillographs with internal photography—the first in which transients photographed themselves by releasing a bistable electronic circuit. Incidentally, the name "Kipprelais" which he gave to the circuit caused many English readers to think that it was invented by a Dr. Kipp but, of course, in German "kippen" means toggling or tumbling. He came to this country in 1934 and worked until the end of 1948 in the research laboratory of the British Thomson-Houston Company, Rugby, during which time he was engaged on communication theory and speech frequency band compression. Dr. Gabor has been at Imperial College since 1949 and has recently been developing a flat, thin, neckless tube for monochrome and colour television, details of which we hope to be able to publish in the near future.

H. A. Fairhurst, who in this issue contributes the concluding part of his article describing an experimental colour receiver, has been with Murphy Radio since 1936 and is at present head of the television research section of the company's electrical design laboratory. He has done original work on a method of producing framing pulses for interlaced scanning and on the suppression of the effects of impulsive interference on television sound reception. Mr. Fairhurst graduated from the Royal School of Mines in 1925 and was working as an exploration geologist in Mexico before turning to radio research in the early 'thirties.

R. W. Addie, M.A., who for the past five years has been manager of the technical-commercial department of Philips which he joined in 1946, has been appointed assistant commercial manager. He will act as deputy to **A. L. Sutherland,** director in charge of television and radio. Mr. Addie, who graduated from Cambridge in 1939 with a degree in engineering, has for the past few years been largely responsible for the sound and television relay installation at the National Radio Show.

R. W. ADDIE.

M. A. E. BUTLER.

Philips' new technical-commercial manager is **M. A. E. Butler,** M.A., who joined the company as an engineer in 1951. He was educated at Oxford and holds an honours degree in physics and a degree in mathematics. After service as signals officer in the R.A.F. he joined the staff of the research laboratories of Standard Telephones and Cables before going to Philips.

J. A. Pim, B.Sc.(Eng.), Ph.D., M.I.E.E., has been appointed chief engineer of the new telecommunication transmission division of Siemens Brothers (see "Business Notes"). Dr. Pim joined the company in 1948 from University College where he had been engaged in research for two years. He was, from 1942 to 1946, at the Royal Aircraft Establishment, Farnborough.

OBITUARY

Norman C. Robertson, C.M.G., M.B.E., deputy managing director of E. K. Cole, Limited, and a director of Ekco Electronics, Limited, died on April 1st, aged 47. Before going to Ekco in 1930 as chief of test, he held a similar position with Kolster-Brandes and had for a short while been with Marconi's. He had been deputy managing director since 1945, having successively been production manager and works manager. In 1951 Mr. Robertson accepted the then newly-created position of director-general of electronics production at the Ministry of Supply. He returned to E. K. Cole in 1953 and the following year was appointed C.M.G. for his two years' voluntary service with the Ministry.

Harold E. Penrose, A.M.I.E.E., who died recently at the age of 69, started his radio career with the Marconi Company as marine operator. For a short while immediately after the first world war he was on the editorial staff of *Wireless World*. He went into the broadcast receiver industry in 1929 as sales supervisor, H.M.V., and had since then held positions with a number of companies, including E.M.I. and Rediffusion.

IN BRIEF

During February the number of television licences in the United Kingdom increased by 110,654, bringing the total to 5,649,266. The total number of **broadcast receiving licences** in force at the end of February, including those for television and 291,740 for car radio, was 14,230,519.

In a breakdown of **television licence figures** for the

We regret that publication of this issue has been delayed. Subsequent issues will appear at intervals of less than a month until the normal time of publication is resumed.

end of December, issued by the G.P.O., 34 towns and districts showed an excess of television licences over sound licences, 19 were around London, 11 in the Midlands and four in the North. Of the English counties, Lancashire and Yorkshire lead with 682,579 and 550,904, respectively. In the London Postal District there were 632,703.

Demonstrations are being given at various harbours in the United Kingdom by Elliott Brothers of a commercial version of the microwave course beacon described in our November, 1955, issue. Forthcoming demonstrations are: Lossiemouth—April 30 and May 1, Whitehaven—May 3 and 4, Fleetwood—May 7 and 8.

Brigg's Festival Hall Concert.—In addition to the advertised programme of live and recorded music, a demonstration of stereophonic reproduction using British and American tapes will be included in the concert on May 12th. At the time of going to press all the cheaper seats had been sold, but tickets at 8s 6d were still available from "hi-fi" dealers in London, the Royal Festival Hall box office or direct from Wharfedale.

B.B.C. Moscow Visit.—In May a B.B.C. delegation is going to Moscow at the invitation of the Soviet broadcasting authority. It will be recalled that a Soviet broadcasting delegation visited this country at the invitation of the B.B.C. last autumn. R. T. B. Wynn, B.B.C. chief engineer, is a member of the seven-man delegation.

Morse Test Fees.—The fee chargeable by the Post Office to prospective amateur licence holders for a morse test has been increased from 7s 6d to 10s. Tests are conducted on request at the G.P.O. headquarters (St. Martin's-le-Grand, London, E.C.1), Post Office coast stations and at the radio surveyor's office at certain ports.

Transistor sales in the United States trebled in 1955 by comparison with the previous year. Figures issued by the Radio-Electronics-Television Manufacturers' Association of America are: 1954—1,317,327; 1955—3,646,802.

I.T.A. over the Border.—The Independent Television Authority has selected a site for its first Scottish transmitter, although authority to erect the station has yet to be granted. The site is at Black Hill, Lanarkshire, midway between Edinburgh and Glasgow and about two miles from the Kirk o' Shotts transmitter of the B.B.C. It is about 800 feet above sea level.

R.E.C.M.F. Council.—At the annual general meeting of the Radio and Electronic Component Manufacturers' Federation on March 21st, the following member firms were elected to form the council (names of the companies' representatives are in parenthesis): Garrard (H. V. Slade), A. H. Hunt (S. H. Brewell), Morganite Resistors (E. T. Treganza), Multicore (R. Arbib), Plessey (P. D. Canning), Standard Telephones and Cables (E. E. Bivand), Telegraph Condenser Company (W. F. Taylor), Telegraph Construction and Maintenance Company (W. F. Randall) and Henry Wiggin (J. S. Mason). In addition Gresham Transformers (J. P. Coleman), N.S.F. (K. G. Smith), and Reliance Electrical Wire (C. H. Davis) were co-opted to the council. The new chairman is S. H. Brewell and the vice-chairman Richard Arbib.

R.C.E.E.A. Council.—There is no change in the representation of member companies on the council of the Radio Communication and Electronic Engineering Association. The member firms and, in parenthesis, their representatives forming the 1956-57 council are: B.T-H. (V. M. Roberts), Decca Radar (C. H. T. Johnson), E.M.I. (S. J. Preston), G.E.C. (M. M. Macqueen), Kelvin & Hughes (C. G. White), Marconi's (F. S. Mockford), Metrovick (L. H. J. Phillips), Mullard (T. E. Goldup), Murphy (K. S. Davies), Plessey (P. D. Canning), Redifon (B. St. J. Sadler) and S.T.C. (L. J. I. Nickels). Last year's vice-chairman, C. H. T. Johnson, is now chairman and the new vice-chairman is S. J. Preston who was chairman last year.

EXHIBITION NEWS

One hundred firms had taken all the available space for the **National Radio Show** (Earls Court, August 22nd to September 1st) over four months before the opening.

Electronics as an aid to materials handling will be exhibited and demonstrated by a number of firms at the **Mechanical Handling Exhibition** at Earls Court, London, from May 9th to 19th. Admission to the exhibition, organized by *Mechanical Handling*, and the international convention held in conjunction with it, costs 2s 6d. It is open daily, except Sunday, from 10 to 6.

A v.h.f./u.h.f. convention is being organized by the Radio Society of Great Britain and the London U.H.F. Group for May 26th at the Bonnington Hotel, Southampton Row, London, W.C.1. It will include an exhibition (which opens at 10), technical lectures, discussions and a dinner in the evening. Among the lectures, which begin at 2.30, is one on "Some aspects of forward scatter." Tickets, price 3s 6d, for the exhibition and convention, may be obtained from F. G. Lambeth (G2AIW), 21, Bridge Way, Whitton, Twickenham, Middlesex, from whom tickets for the lunch and dinner are also obtainable.

Twenty-nine firms are participating in the exhibition, "**Atoms, Electrons and Industry,**" which the electronics section of the Scientific Instrument Manufacturers' Association is organizing for June 6th to 8th at the Royal West of England Academy, Bristol. Admission is by ticket obtainable free from S.I.M.A., 20, Queen Anne Street, London, W.1.

The products of over forty companies, the majority foreign, will be shown at the second **International Instrument Show** which is being organized by B & K Laboratories Limited at Denison House, Vauxhall Bridge Road, London, S.W.1, from May 7th to 18th. The firms exhibiting are: U.S.A.—Advance Electronics, Allen-Bradley, Ampex, Brush, Electrical Industries, Electro-Voice, Electronic Tube Corp., Heath, M.B. Mfg. Co., Narda, New London Instrument Co., Polarad, Polytechnic R. & D., Raytheon, Sperry, Sprague, Sylvania, Varian; Switzerland—Metrohm, Muller-Barbieri, Vibrometer; Denmark—Bruel and Kjaer; Holland—Peekel Laboratories; Sweden—Sivers Lab.; Italy—Firar; France—Detectron; Germany—Hackethal, Linde, Belzer, Grundig; U.K.—Avo, Advance Components, G. & E. Bradley, Cinema Television, Clarke and Smith, Cossor, Furzehill, Grayonics, Kelly, Microwave Instruments. Tickets are obtainable from the organizers at 57 Union Street, London, S.E.1.

The system of electronic machine tool control, which was mentioned in our February issue, is being featured by E.M.I. Electronics at the **Production Exhibition** which opens at Olympia, London, on May 23rd for eight days. A number of other applications of electronics to production will be included in this second exhibition sponsored by the Institution of Production Engineers.

BUSINESS NOTES

Siemens Brothers have formed a telecommunication transmission division which will be responsible for the development, manufacture, sales and installation of all radio-line terminal equipment, multi-channel carrier telephone and voice-frequency equipment and voice-frequency telegraph apparatus. Dr. J. A. Pim is chief engineer (see "Personalities").

The B.B.C. has ordered 17 of the new **Emitron** television cameras which are mentioned in our review of the Television Society exhibition (see page 164). To enable the operator to maintain a comfortable stance the electronic view-finder can be kept horizontal when the camera is tilted for high- or low-angle shots.

The entire fleet of Bristol Britannia aircraft operated by B.O.A.C. is to be fitted with **Ekco** search radar for the detection of turbulent cloud formations.

H.M.V.-R.C.A. Break.—As from May next year new H.M.V. recordings will be released in the United States and Canada by Electric and Musical Industries Limited through their own companies. From that date new recordings issued in the United States by Radio Corporation of America will no longer be released in the United Kingdom by the Gramophone Company.

Decca-R.C.A. Agreement.—Following the above announcement the Decca Record Company stated that they had acquired the right to manufacture and sell as from May 1st, 1957, all new R.C.A. Victor recordings. A year later all R.C.A. Victor records will be available for manufacture and sale by Decca under the R.C.A. label.

A company under the title of **Siemens-Ediswan Limited** has been formed to fuse the interests of Siemens Brothers and Company with those of the Edison Swan Electric Company. The two companies will continue to trade as independent concerns but matters relating to research, development, manufacture and distribution will be co-ordinated. Dr. J. N. Aldington has been appointed managing director of Siemens-Ediswan.

Marconi-A.T.&E. Co-ordination.—The Automatic Telephone & Electric Company and Marconi's Wireless Telegraph Company have concluded an agreement for co-operation in the field of telecommunications. The development, production, planning, installation and maintenance resources of the two companies will be co-ordinated, to enable them jointly to meet the widest possible range of telecommunications requirements.

All valves previously sold by the General Electric Company under the trade mark **Osram** will in future bear the trade mark **G.E.C.** This change applies only to valves and not to other products using the Osram trade mark.

An agreement between **E.M.I. Electronics Ltd.**, of Hayes, and **Industrial Electronics**, of Magnet Works, Derby Road, London, S.W.14, provides for E.M.I. to act as sole selling agents at home and overseas for the instruments produced by Industrial Electronics.

Cossor announce the signing of an agreement between themselves and K.G.H. (Holdings) Pty. Ltd., of Sydney, Australia, whereby "the Australian company obtains the full present and future know-how of the English company in the design and production of television receivers." Cossor television receivers will be marketed in the Commonwealth by Jacoby, Mitchell and Co. Pty. Ltd. (Cossor agents) and Titanvision receivers by K.G.H.

A substantial interest in W. Watson and Sons, Ltd., of Barnet, the manufacturers of the zoom lens used in television cameras, has been acquired by **Pye Ltd.** Founded in 1837, Watson's are primarily optical and scientific manufacturers.

Honeywell-Brown Ltd., of 1, Wadsworth Road, Perivale, Middlesex, are to manufacture and market the micro-switches developed by the Minneapolis Honeywell Regulator Company, their American associates. The overall size of one type, which will carry 5 amps at 250 volts A.C., is approx. $\frac{1}{2}$in × $\frac{1}{2}$in × $\frac{1}{4}$in.

Pye telecommunications equipment was used for ground-to-air communication during the record breaking flight of the Fairey Aviation Company's Delta 2. The aircraft was tracked by radar and the pilot informed by radio when he was entering and finishing the measured course.

E. K. Cole Limited announce that Ekco electronic equipment plays an important role in the "Fairey Fireflash" guided weapon system, which is now in production for the R.A.F.

Cable markers, or printed sleeves, in rubber, synthetic rubber or P.V.C., indelibly printed with any wording, are now available from **Creators Limited**, Plansel Works, Sheerwater, Woking, Surrey, at twenty four hours notice.

A.E.I.-Ekco Link.—Negotiations are under way for the formation of an Australian company to be owned jointly by Associated Electrical Industries Limited and E. K. Cole Limited. The new factory will be at Yennora, near Sydney, and is expected to be producing receivers by the time a television service is started in the Commonwealth.

Lithgow Electronics Limited, of 1, Grange Court, Sudbury Hill, Harrow, Middlesex, have been appointed sole representatives in the United Kingdom and Eire of the Hewlett-Packard Company, instrument manufacturers, of California, U.S.A. The servicing of the equipment will be undertaken by Livingston Laboratories Limited, of Retcar Street, London, N.19.

OVERSEAS TRADE

January Exports.—After a record-breaking year in 1955—as reported last month—exports of radio equipment of all kinds in January were valued at £2.9M, a record for the first month of a year. Export figures for each section of the industry were higher than the corresponding values for January, 1955.

Canada.—Contracts valued at $200,000 for the supply of telecommunication measurement equipment to the Canadian Department of Defence have been awarded to Marconi Instruments. The contracts, which were secured in conjunction with the Canadian Marconi Company "in face of severe competition from American organizations," are for frequency meters, wattmeters, universal bridges and signal generators—one f.m. signal generator having been specially designed to conform to North American standards.

Switzerland.—Under a contract recently concluded between 20th Century Electronics, of New Addington, Surrey, and Landis and Gyr, of Zug, Switzerland, 20th Century cathode-ray and geiger tubes will be marketed exclusively in Switzerland by the Swiss company and in Western Germany by their associates, Paul Firchow Nachfolgen. The licence also provides for the British company to train foreign engineers and allows the overseas parties the right to use British designs and patents.

Paris.—Radio-telephone equipment for fifty Parisian taxis—said to be the first radio-equipped taxis in the city—has been supplied by Pye Telecommunications.

Iraq.—Redifon radio-telephone equipment has been installed at Iraq's Kirkuk oil-field and the refinery at Daura, near Baghdad. This will enable information on tankage capacity and the different kinds of oil being pumped to be passed continuously between the two centres.

Only three of the eighty or so British manufacturers who exhibited at the **Lyons International Fair** (April 7th to 16th) are in the radio industry. They are Erie, G.E.C., and S.T.C.

Hungary.—Television outside broadcasting equipment is being provided by Pye for the Hungarian television service which is to be inaugurated later this year.

Norway, which has had an experimental v.h.f. broadcasting station operating for some time, has recently ordered eleven 5-kW f.m. transmitters from Marconi's.

Canada.—Decca surveillance radar equipment is being supplied to the Canadian Department of Transport for the airports at Toronto, Montreal, Winnipeg and Vancouver.

Borneo.—A v.h.f. radio-link has been supplied by Automatic Telephone & Electric Company to the broadcasting organization in British Borneo to feed B.B.C. news bulletins, received at Batu Kawa, to the main studios at Kuching five miles away.

Karachi.—Equipment for a number of fixed and mobile radio-telephone stations has been supplied by Intercommunications Equipment Company, of 286-288, Leigh Road, Leigh-on-Sea, Essex, to the police force in Karachi, Pakistan.

Low-Distortion F.M.

Resistance-Coupled Pulse-Counting Circuit Needing No Alignment

IN the July 1955 issue there was a letter from J. K. Carter entitled "F.M. Receiver Design" in which he inquired "What has happened to Thomas Roddam's circuit? Does it really work?" The circuit to which he referred was described in the July 1948 issue under the title "Why Align Discriminators?" and took the form of a simple pulse counter instead of one of the usual phase discriminators with their need for accurate and skilled alignment.

Investigation of this circuit supplies the answer, which is a definite "Yes." It works very well. It gives the home constructor f.m. reception without the daunting problem of aligning discriminators and i.f. amplifiers and also without the 3% distortion of which Mr. Carter complained. And a receiver incorporating it can be actually cheaper and simpler than conventional designs. As Mr. Roddam pointed out, however, its advantages are at the expense of efficiency (in the technical sense), so are most readily obtainable where there is a fairly strong signal, say within the 1 mV/m contour. There seems to be no reason, however, except for some sacrifice of simplicity, why this discriminator should not be used in a highly sensitive receiver.

In order to understand clearly what is involved in its design, let us begin at the beginning.

The process of frequency modulation varies the number of signal cycles entering the receiver per given small period of time. Fig. 1(a) shows (somewhat exaggeratedly) two such periods, at opposite peaks of modulation. The problem is to derive an output signal that is continuously proportional to the number of cycles. It is not enough simply to rectify the incoming signal, as at (b); the rectified output is constant, because each increase in number of cycles is exactly balanced by their reduced duration. But if the signal cycles are employed to generate pulses all of equal size, as at (c), their mean value over the period (indicated by the height of the dotted line) is exactly proportional to their frequency, which is the same as that of the f.m. signal, and so the requirements of a discriminator are fulfilled.

The first practical problem is to ensure that the pulses are all the same size, regardless of frequency and amplitude of the signal. This is easier than might be expected. Their "size" is the number of volt-seconds, represented on voltage/time graphs such as Fig. 1 by area. If the voltage is caused by a quantity of electricity passing through a resistance, then (since quantity is the number of amp-seconds, called coulombs) all that is necessary is to ensure that the resistance and the quantity are the same for each.

If, in Fig. 2, the slider is moved from V_1 to V_2 the difference $V_2 - V_1$ being V volts, then the quantity of electricity flowing through R during the time necessary for this difference to occur across C is VC coulombs, and the size of the voltage pulse across R is therefore VCR volt-seconds. There is of course no difficulty in keeping C and R constant; and V can be made the same each time, in spite of variations in signal amplitude, by deriving it from a limiter stage, as in receivers employing the Foster-Seeley discriminator.

Note that the size of the pulse does not depend on the time taken for the voltage change to take place at the source. But time must be allowed for the pulse to be practically completed before the source voltage starts to reverse. A sinusoidal signal, as in Fig. 1(a), would not do, because it starts to reverse immediately it reaches its peak in either direction. But the limiter can be used to distort the sine wave into something nearer a square wave, whose flat top allows some time for the charging of C, delayed by R, to continue. The important thing is that it should always allow enough time. If the longer cycles on the left of Fig. 1, corresponding to negative peak modulation, did allow enough time, and the shorter pulses on the right, corresponding to positive peaks, did not, the pulses would not all be exactly the same size, so the mean value would not be exactly proportional to frequency and the a.f. output would be distorted.

Fig. 3 shows the pulse-forming circuit driven by a limiter stage of the type proposed by Roddam. When an adequate signal is supplied to the grid, the valve alternately "bottoms" and is cut off. In the bottomed condition the anode voltage is quite low, and when cut off it rises to the full supply voltage V_b. It cannot do so instantaneously, however, even if for simplicity we suppose that the anode current is cut off instantaneously. Let us follow the action in detail, beginning with the bottomed condition. Assuming it has lasted long enough for the

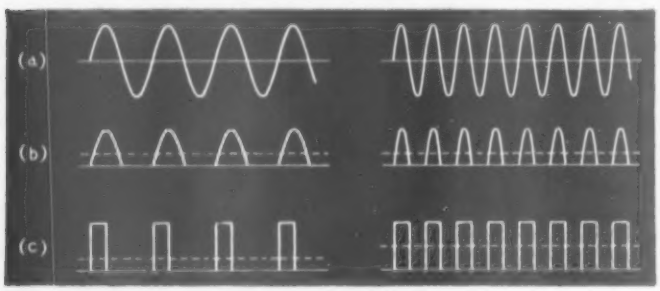


Fig. 1. At opposite peaks of modulation, a f.m. carrier wave has different numbers of cycles in a given period of time, as shown at (a). The rectified and smoothed output (b) is the same for both, but if pulses of constant size are substituted (c) the output, shown dotted, is exactly proportional to frequency.

Discriminator

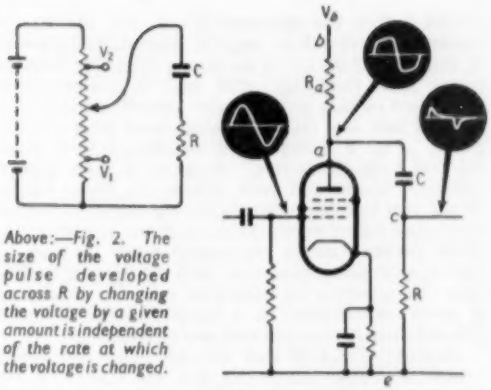
By M. G. SCROGGIE, B.Sc., M.I.E.E.

voltage across C to become constant, there can be no current flowing through R and so no voltage across it, and point *c* in Fig. 3 must be at the same potential as *e*, as shown at the start of Fig. 4. The large anode current through R_a brings the anode *a* down to, say, 25 volts, which is therefore the voltage across C.

Now suppose the anode current is instantaneously cut off. The voltage V_b from *e* to *b*, being kept constant by a smoothing capacitor, remains unchanged, say at 125 volts. The voltage across C cannot alter instantly so is still 25, therefore the remaining 100 must divide between R_a and R in proportion to their ohmages. It is this that gives the sudden voltage peak across R. Roddam calculated it to be 50 volts, but this is impossible with the values he chose ($V_b = 70$, $R_a = 10\,k\Omega$ and $R = 1\,k\Omega$). The current now flowing through R_a and R proceeds to charge C towards 125 volts. The nearer it approaches, the less the voltage left to drive the charging current through R_a and R, so the charging current and the voltage across C die away in the manner called exponential, as shown by *c* in Fig. 4. The anode potential *a* meanwhile rises in the same manner towards *b*. Theoretically this process goes on for ever, and as we cannot wait so long we have to decide on the stage at which it can be deemed to be finished.

The rate of decay is determined by C and the resistance through which it is charged ($R_a + R$). In the period known as the time constant, $= (R_a + R)C$, the voltage has dropped to 36.8% of its starting value. With this particular shape of curve, the percentage of pulse "area" that remains to come (if it went on for ever) happens conveniently to be equal to the percentage of voltage remaining at that point; 36.8% is of course far too much to neglect. Roddam chose four times the time constant, on the supposition that by then the voltage had dropped below 1%, but this is incorrect; it is still 1.8%. Suppose we decide on five times, at which only 0.7% of the pulse is left. This, then, is the minimum allowable time for the positive half of the square wave. Assuming that it actually is a half, then the shortest whole cycle is $10(R_a + R)C$ and the highest allowable signal frequency is therefore $1/10(R_a + R)C$.

To obtain proper limiting action, R_a ought not to be too small; neither ought R if a reasonable output is to be obtained. So one would be inclined not to go below 10 kΩ for $R_a + R$. C ought to be sufficiently large for stray capacitances not to matter; say, not much less than about 40 pF. Filling in these values, we get as the highest frequency 250 kc/s. This being at the positive peak of modulation, the carrier frequency for a deviation of 75 kc/s would be 175 kc/s, and the minimum 100 kc/s. One could go somewhat lower, say 50 kc/s, without running into difficulty in separating it from the highest a.f., and a margin at least as wide as this is most desirable in order to allow for inaccuracy or drift of tuning. "Carrier frequency" throughout this article refers, of course, to the frequency to which the carrier actually broadcast is reduced by means of the receiver's frequency changer. It occupies the centre of the i.f. band, which, as we have just found, extends in this type of receiver from about 50 to 250 kc/s.



Above:—Fig. 2. The size of the voltage pulse developed across R by changing the voltage by a given amount is independent of the rate at which the voltage is changed.

Above right:—Fig. 3. Outline of circuit for producing equal voltage pulses from a signal of varying frequency.

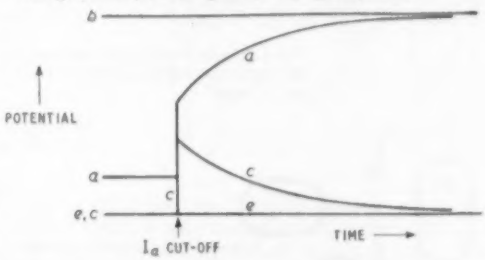


Fig. 4. If the anode current in Fig. 3 is cut off instantaneously by the down swing of a arge input signal, the potentials of the various points are affected as shown. The desired voltage pulse is obtained at c.

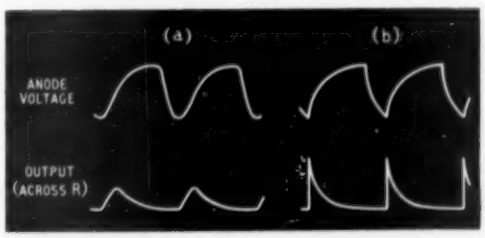


Fig. 5. Actual waveforms obtained in a circuit of the Fig. 3 type (with rectifier added to remove negative pulses), with (a) small and (b) large input signal amplitudes. Despite the very different peak values and shapes of the output pulses, they are equivalent, thanks to the principle illustrated in Fig. 2. The output pulses at (b) are very close to the theoretical shape—c in Fig. 4.

It may be objected that the foregoing calculation is unsound, being based on the assumption of a perfect square wave, allowing a complete half-cycle for dying-away purposes. But the larger the proportion of the half-cycle occupied by the sloping rise, the greater the proportion of the pulse that

occurs before the exponential tail, and the less it matters if that tail is slightly clipped. Moreover, if the limiter circuit is as shown (Fig. 3), without series grid resistance, grid bias is automatically developed which extends the cut-off period well beyond half the cycle, allowing more time for the pulse. Fig. 5 shows actual waveforms with small (a) and large (b) inputs. In spite of their greatly different shapes and peak values, the mean values of the two lots of output pulses are the same within very close limits over a 100-to-1 input voltage ratio. This perhaps rather surprising result is due to the simple basic principle with which we began, that the quantity of electricity required to charge a given capacitance to a given voltage is quite independent of the time and rate of charging.

Another objection that will no doubt be raised —and this time rightly—is that the circuit so far shown would on the down swings produce negative pulses, and these are not shown in Fig. 5. They can be eliminated by cutting off R from negative voltages by a diode, D_2 in Fig. 6. C is meanwhile being discharged via D_1. Obviously these diodes should have as low forward resistances as possible, so as not to increase the time constants appreciably. Satisfactory results have been obtained both with an EB91 thermionic double diode and a pair of GEX36 germanium diodes, the latter being of course neater and more convenient. Care should be taken to connect them as shown, so that the positive pulse is the one used; this is to allow it the longer "half"-cycle in which to take place. The negative pulse can make do with the shorter half because it has a shorter time constant, R then not being in circuit.

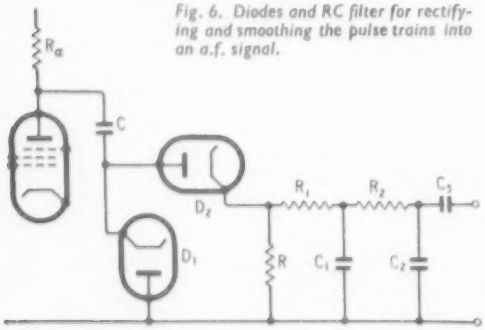


Fig. 6. Diodes and RC filter for rectifying and smoothing the pulse trains into an a.f. signal.

As the received signal is modulated, the pulses across R alternately close up and open out their ranks, so the average voltage across R rises and falls at modulation frequency. To prevent the relatively high peak voltages reaching the a.f. amplifier, some filtration is needed. An elaborate inductive filter is unnecessary, for a good start is made by the de-emphasis circuit that would in any case be needed to reduce the upper audio frequencies deliberately over-emphasized at the transmitter. The correct amount is provided by a CR potential divider having a time constant of 50 μsec.; that is to say, $C_1R_1 = 50 \times 10^{-6}$. At the same time R_1 must be large enough not to shunt R heavily; about 50 kΩ is suitable, in which case C_1 would be $50 \times 10^{-6}/(50 \times 10^3) = 10^{-9}$F or 1,000 pF. As this alone gives only a 6-dB per octave slope-off, which is scarcely enough for filtration, it may be supplemented by R_2 and C_2, designed not to increase the a.f. cut-off appreciably but to reduce the lowest i.f. If R_2 is also 50 kΩ and the cut-off frequency (−3 dB) is 30 kc/s, C_2 works out at about 100 pF. The two-stage filter just specified gives slightly more cut than that calculated on a separate-stage basis, and the standard values 47 kΩ were in fact adopted. The filter is suitable for connecting through a blocking capacitor C_3 to an a.f. amplifier having an input resistance not much below 0.5 MΩ and capacitance not much more than 10 pF. Fig. 7 shows the measured voltage/frequency characteristic.

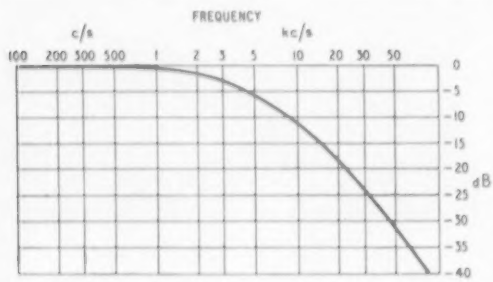


Fig 7. Measured frequency characteristic of output filter with component values as in Fig. 9.

We have estimated that $R_a + R$ should preferably not exceed about 10 kΩ, but the best individual values have yet to be settled. We know that for a given V—the difference in anode voltage between the bottomed and cut-off states—the output is proportional to R. If $R_a + R$ is kept constant and R is increased from zero, the output is at first proportional to R; but as R_a falls, V falls at an increasing rate until at a certain ratio of R:R_a it balances the increase due to R. That is the optimum as regards magnitude of output, and with an EF80 high-slope pentode at V_b equal to 80 to 100 volts it turned out to be 6.5 kΩ for R to 3.5 kΩ for R_a. As R_a is reduced, however, the limiting action becomes less good and valve currents increase; so, since 5 kΩ:5 kΩ gives nearly as much output that ratio was adopted. It gives about four times the output of the 1 kΩ:10 kΩ ratio, the five-fold increase in R being offset by only a 20% reduction in V due to the halving of R_a. Indirectly, the increase in R:R_a ratio yields a further increase in output, because the difference between the time constants (R_a + R)C and R_aC for positive and negative pulses respectively enables a larger proportion of the cycle to be allowed for the positive pulse and hence a greater mean pulse voltage. It

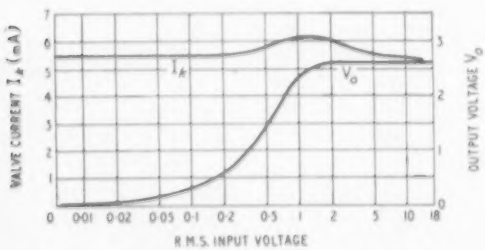
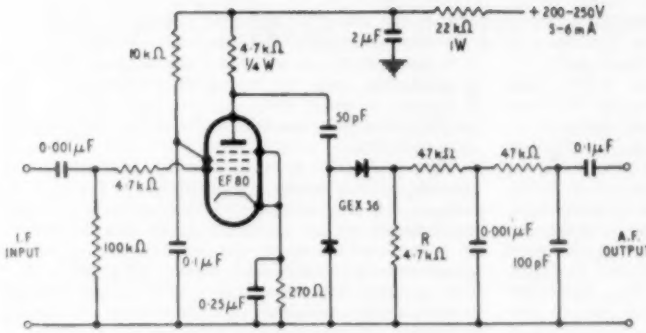
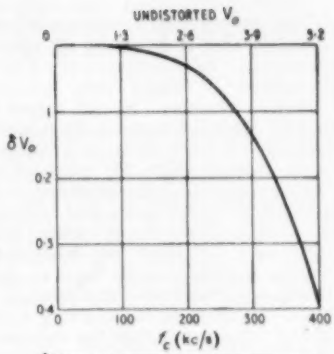
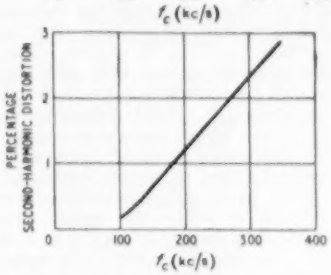


Fig. 8. Z.f. output across R (V_o) and cathode current (I_a) against r.m.s. input voltage: circuit as in Fig. 9.







Above:—Fig. 9. Recommended circuit of limiter and discriminator.

Above right:—Fig. 10. Departure of V_o/f_c curve from linearity in Fig. 9 circuit. The values of V_o if linearity were perfect, from which δV must be subtracted to give the actual curve, are shown along the top.

Right:—Fig. 11. Second-harmonic distortion due to non-linearity shown in Fig. 10, for 75 kc/s deviation, plotted against carrier frequency, f_c. All other harmonics are extremely small.

has, in fact, been found quite feasible to raise C to 50 pF, giving a proportionate increase in output.

These benefits in output are welcome, because the efficiency of this type of discriminator is admittedly low. The output can easily be calculated, by assuming instantaneous I_a cut-off and making use of the fact that the pulse is then equivalent to one maintaining the same peak value for $(R_a + R)C$ seconds. The peak output voltage is $VR/(R_a + R)$, and its mean value V_o is given by multiplying this by the ratio of $(R_a + R)C$ to the period of one signal cycle, which at the carrier frequency f_c is $1/f_c$. So

$$V_o = VRCf_c$$

Taking V = 60, R = 5 kΩ, C = 50 pF, and f_c = 150 kc/s, V_o (which is the z.f. output across R) is 2.25 volts.

It follows that the r.m.s. audio voltage with deviation f_d is

$$V_{rms} = \frac{VRCf_d}{\sqrt{2}}$$

so with the values given and 75 kc/s deviation it would be 0.8 volt. This compares with 0.17 volt for R = 1 kΩ, C = 40 pF and V = 80; an advantage of 13.5 dB.

It is convenient to have a V_o of several volts, for operating a tuning indicator and/or automatic frequency correction. The output being proportional to V, which is roughly proportional to V_b within practical limits, V_o can be matched by a point on a potential divider across V_b. Any difference between V_o and the potential of this point will therefore be due to a change in f_c, the carrier frequency. By adjusting the frequency-changer oscillator—manually or automatically—to bring the potential difference to zero, correct tuning is ensured.

Incidentally, the fact that the output depends on V_b points to the need for good smoothing in the supply system, because residual hum there would be reproduced in the output.

Next, there are the questions of whether to run the screen grid at a lower potential than V_b, and how much cathode resistance to use, if any. The many measurements that have been made can be summarized by saying that neither has much influence on performance and current taken under working conditions—i.e., with sufficient signal to cause limiting—but that R_{g2} and R_k both reduce I_a and I_{g2} considerably when there is little or no signal. By a suitable choice of R_k, the total current $(I_k = I_a + I_{g2})$ can be kept fairly constant for all signal amplitudes. Fig. 8 shows the results with V_b = 120, R = R_a = 4.7 kΩ, R_{g2} = 10 kΩ, and R_k = 250 Ω. Note that output is substantially constant for all signal input voltages above 1.5 r.m.s. Similar constancy of I_k was obtained, and about 5% greater output, with no R_{g2} and R_k = 470 Ω, but the minimum signal input for limiting was raised about 25%.

These results refer to a carrier frequency of 200 kc/s, which is within the reasonably linear range. It is obviously desirable for this range to be considerably wider than the f.m. deviation, in order that great precision and constancy of tuning is not necessary to ensure a low level of distortion. While this was being investigated it became clear that when the signal amplitude was large the ratio of positive to negative epochs in the cycle was excessive and was the first cause of non-linearity at the high-frequency end. The optimum ratio is given by the ratio of the time constants during the positive and negative pulses, which is $(R_a + R):R$, or 2:1 in the circuit under consideration. Inserting a 4.7 kΩ resistor in series with the grid of the limiter valve enables a wider frequency range to be obtained at large signal amplitudes. This was included for the plotting of Fig. 8. Fig. 9 shows a recommended practical circuit, following closely the foregoing lines.

Although the useful range of signal amplitude is very wide, 5-20 volts is a suitable order of magnitude.

Linearity is so good, even with the circuit values shown, chosen more for output level than for extreme linearity, that it is not at all easy to measure the distortion. In the absence of a f.m. signal generator modulated $\pm$ 75 kc/s with less than 0.1% total harmonic distortion, the z.f. output voltage (V_o) was plotted against frequency by a method designed to exclude voltmeter error, and the curve of departure from linearity (Fig. 10) analysed in two different ways to determine the harmonic distortion at 100% modulation ($\pm$ 75 kc/s). One way was by measuring the vertical differences at selected points between the curve and a straight line and calculating the percentage harmonics from them as described in *Radio Laboratory Handbook*, 6th edition, p. 302. The other was to devise an equation giving a curve close to that of Fig. 10 and calculate the outputs at fundamental and harmonic frequencies for various values of f_c when $f = f_c + 75 \cos \omega t$. The results of these two methods agreed well, and Fig. 11 shows percentage second harmonic as a function of the carrier frequency f_c. Third harmonic is of the order of 0.1%, and higher harmonics negligibly small.

If the lowest allowable instantaneous frequency to keep well clear of the highest modulation frequency is taken as 25 kc/s, this puts the lower limit of f_c at 100 kc/s, at which the second harmonic is barely 0.2%. The designed f_c is 150 kc/s, but Fig. 11 shows that this can be considerably exceeded before distortion is as great as with other types of discriminator at their very best. And whereas these other discriminators can very easily fall much below their best, even if they were sufficiently well adjusted in the first place ever to have attained it, the counter discriminator can hardly give bad linearity, short of gross errors in component values. And whereas conventional discriminators have modulation characteristic curves with comparatively sharp bends at both ends, capable of giving large amounts of the most objectionable kinds of distortion if traversed, the counter discriminator (once the audibly obvious clash of i.f. with a.f. has been cleared) has a wide range of adjustment within which distortion consists almost exclusively of a small percentage of second-order, which is relatively innocuous. It should be remembered that Fig. 10 refers to 100% modulation, and at the lower depths that prevail nearly all the time the distortion is far lower still. In other words, it is probably fair to say that discriminator distortion is negligible, even by high-fidelity standards. But if anyone is really fussy, he can reduce what distortion there is as much as he likes, by reducing the time constant.

This ordinarily means reducing output in proportion, but an interesting possibility is the use of a cathode follower between the limiter and discriminator proper. This is actually shown in a description of a receiver to which the writer's attention was drawn after the work described here had been done.* This receiver was for rather special duties, using a 1-Mc/s carrier modulated up to 150 kc/s at $\pm$ 250 kc/s deviation, and required as much as 0.1 V signal at the input to six limiter stages! Another receiver†, this time for broadcast transmissions, was also designed for a comparatively high i.f. (500 kc/s) with the object of rendering tuning non-critical, and uses the same kind of double-triode coupled-cathode limiter stages, four in number, with 2.5 mV input. The same article suggested the use of the double superheterodyne principle for achieving a high sensitivity in a receiver using a counter discriminator.

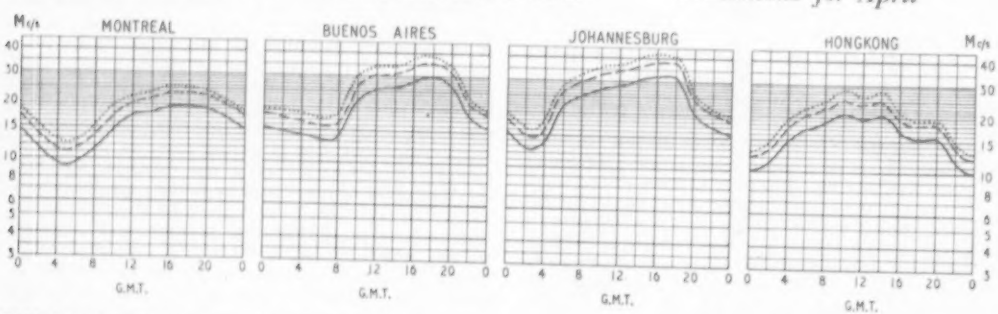
What appears to be the first description of the counter discriminator‡ made use of it for measuring distortion elsewhere, and therefore had to be virtually distortionless itself; its z.f. output/frequency characteristic is claimed to have departed less than 0.02% from perfect linearity from 50 to 250 kc/s. For the purpose in view, sensitivity was unnecessary, and in fact the 40 Mc/s input to the complete receiver was at the level of 1 to 25 *volts*!

As mentioned at the start, however, the great advantages of the counter discriminator can be obtained in a simple and practical receiver for broadcast reception, and in a later article it is hoped to give details of this.

*" Counter-Circuit Multiplex Receiver," by Vallarino, Snow and Greenwald, *Electronics*, July 1953, p. 178.
†" Mobile F-M Broadcast Receiver Design," by K. Onder, *Electronics*, May 1954, p. 130.
‡" Generation and Detection of Frequency-Modulated Waves," by Seeley, Kimball and Barco, *R.C.A. Review*, Vol. 6 (1942), p. 269.

SHORT-WAVE CONDITIONS

Predictions for April



THE full-line curves given here indicate the highest frequencies likely to be usable at any time of the day or night for reliable communications over four long-distance paths from this country during April.

Broken-line curves give the highest frequencies that will sustain a partial service throughout the same period.

..... FREQUENCY BELOW WHICH COMMUNICATION SHOULD BE POSSIBLE FOR 25% OF THE TOTAL TIME

— — — PREDICTED AVERAGE MAXIMUM USABLE FREQUENCY

——— FREQUENCY BELOW WHICH COMMUNICATION SHOULD BE POSSIBLE ON ALL UNDISTURBED DAYS

Television Society's Exhibition

INSTEAD of being an evening affair only, this year's exhibition was held on three consecutive days, March 6-8, mainly during the daytime. The longer hours so spread out visitors that it was much easier to see the exhibits, and the change has been a great improvement. In its new home at the Royal Hotel, Woburn Place, too, more space was available.

Several exhibits dealt with the transient-response testing of television receivers. G.E.C. showed apparatus generating a sine-squared pulse of 0.2 μsec duration with a repetition frequency of 70 kc/s. The receiver output is displayed on a c.r. tube and the effects of receiver bandwidth on its shape are reflected in the curve traced upon the tube screen. The characteristic broadening of the pulse by too narrow a bandwidth, and the ringing following the pulse caused by unsuitable phase characteristics, were well in evidence in the demonstration.

Ferguson showed simplified transient test apparatus for use in production testing. A square-wave modulation of the r.f. signal is used and the receiver output is applied directly to the Y plates of a c.r. tube. The timebase voltage for the X plates is obtained by filtering the square wave to obtain its sinusoidal fundamental. A switched delay line enables the relative timing of the two to be varied in steps of 0.05 μsec.

More in the field of measurement than testing is the Leland Group-Delay measuring set, Model 98, Mark II. This can be used for any transmission system operating in the 50—70-Mc/s band. It can be used to measure group delays of up to 200 mμsec with an accuracy of $\pm$0.5 mμsec, and the amplitude response from zero to 20 dB. The apparatus has an oscillator sweeping from 50 Mc/s to 70 Mc/s with a repetition rate of 50 c/s. It is frequency modulated at 1 Mc/s with a deviation of 0.5 Mc/s. After passing through the network under test, and being delayed by it, this signal is compared with the original 1-Mc/s modulation. From the comparator, an output at 1 Mc/s, amplitude-modulated in accordance with the delay, is obtained. After demodulation, this provides a voltage proportional to the group delay and is applied to the Y plates of a c.r. tube, to the X plates of which the 50-c/s sweep is applied. The group-delay characteristic is thus displayed in much the same way as the more usual equipment depicts the amplitude-response characteristic. The apparatus can also produce such an amplitude characteristic and marker "pips" are provided.

A wide range of foreign, and some British, measuring apparatus was shown by Livingstone Laboratories. Among this, the Heinz Gunther Neuwirth f.m. signal generator is noteworthy in having a range of 19–230 Mc/s of fundamental frequencies; there is an i.f. range covering 9.5–12 Mc/s operating on the b.f.o. principle. The maximum deviation is 110-kc/s and amplitude modulation can be applied from an external source simultaneously with the f.m.

A French television pattern generator, the S.I.D.E.R., produces a waveform in accordance with the 625-line C.C.I.R. standard. The pattern includes a series of 5-Mc/s bars.

A compact direct-reading frequency-meter by Gertsch Products of Los Angeles covers 20–1,000 Mc/s and an accuracy of one part in 100,000 is claimed.

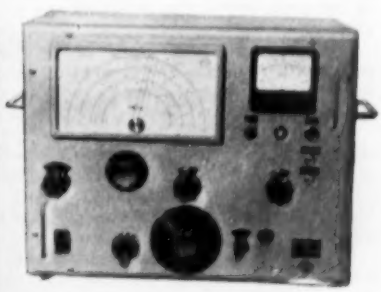
In the serviceman's category is the Avo signal-generator Type III, which covers 150 kc/s to 220 Mc/s. A prototype of the same firm's T.F.M. was also shown; this has one f.m. band in addition to a wide coverage with a.m.

Cossor showed the well-known Telecheck, covering Bands I and III, and had a new oscilloscope, Model 1058, with a d.c.-coupled signal amplifier having an upper limit of response of 6 Mc/s. It has a 4-in. tube with post-deflection acceleration of the electron beam.

There were a good many oscilloscopes and associated equipment on view. Among the latter, the Mullard television line selector can be used with any triggered oscilloscope. It enables any line of a television picture to be selected at will and displayed on the oscilloscope. In addition, at 50 c/s, both odd and even frames can be displayed superimposed upon each other so that differences between them can readily be seen.

Several picture monitors were on view. The Cintel has a 14-in. tube and especial care has been taken in the design of the focus and deflector coils in order to secure good focus over the whole picture area. The associated amplifier has a response flat within $\pm$0.5 dB up to 3 Mc/s and is phase corrected. The Murphy Radio monitor includes a two-band receiver. It has a 9-in. tube with a wideband video amplifier arranged to accept an input either from the internal receiver or from any external source.

Ediswan demonstrated equipment for determining the optimum grading of turns in a deflector coil. The assembly is made with a normal frame winding and a line coil split into two parts. All windings are fed at 50 c/s and the grid of the tube is pulsed



H. G. Neuwirth f.m. signal generator.

Left: Avo Type III signal generator.

20th Century Electronics series D6 square-face tube with two guns.

New Emitron camera with electronic viewfinder.

Rear view of Leland meter showing the movement in one corner at the back of the scale.

at the peak of the deflecting wave so that only a spot appears on the screen. This can be moved to any part of the screen by adjusting the currents, and changes in its shape are at once evident. A control enables the ratio of the currents in the two parts of the line coil to be adjusted and, by determining the optimum ratio, the proper grading of turns in the winding can be deduced.

Ediswan also showed the use of an electrostatic lens between the mask and the screen of a colour c.r. tube. By giving some focusing action, it improves efficiency by permitting the use of larger holes in the mask and it also improves the deflection sensitivity.

The large and the small in c.r. tubes was in evidence here also. The new 24-in. tube for operation at 20 kV was shown, as well as a 9-in. with tetrode gun and ion trap.

20th Century Electronics showed their well-known range of precision oscilloscope tubes with up to four guns. Some new types are built with square and rectangular faces in order to reduce the space. Mumetal screens for tubes of these new shapes were displayed by T.M.C.

The G.E.C. exhibit took the form of a series of demonstrations of an experimental nature. One showed the use of a transistor as a sync separator in a television receiver. Another illustrated a special circuit designed to keep the black level of a television picture at a fixed value despite variations in the e.h.t. supply. It does this by appropriately changing the d.c. gain of the amplifier. It includes a gated a.g.c. system.

The printed circuit is gaining in popularity and T.C.C. exhibited many examples of it in the form of i.f. filters and aerial crossover networks. It is being applied also to television tuners where the rigid and consistent placing of connections is very helpful in enabling consistency of performance to be secured. It is even being applied to aerials! T.C.C. showed some Band III V-dipoles for building into a receiver; in one example, the dimensions were reduced by centre loading, the "coil" for this being printed with the aerial "rod".

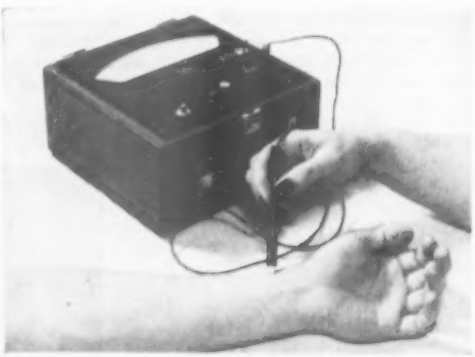
Belling-Lee displayed a rotating aerial mechanism with electrical remote control of its orientation. It can be used, and was so demonstrated, in continuous rotation in plotting the directional characteristics of an aerial. A calibrated v.h.f. receiver for field-strength measurement was also shown.

Another instrument of this character is the J.S.F. field-strength meter shown by Fielden. It is claimed to have an accuracy of ±10% on Band I and ±25% on Band III; it is intended for checking aerial performance.

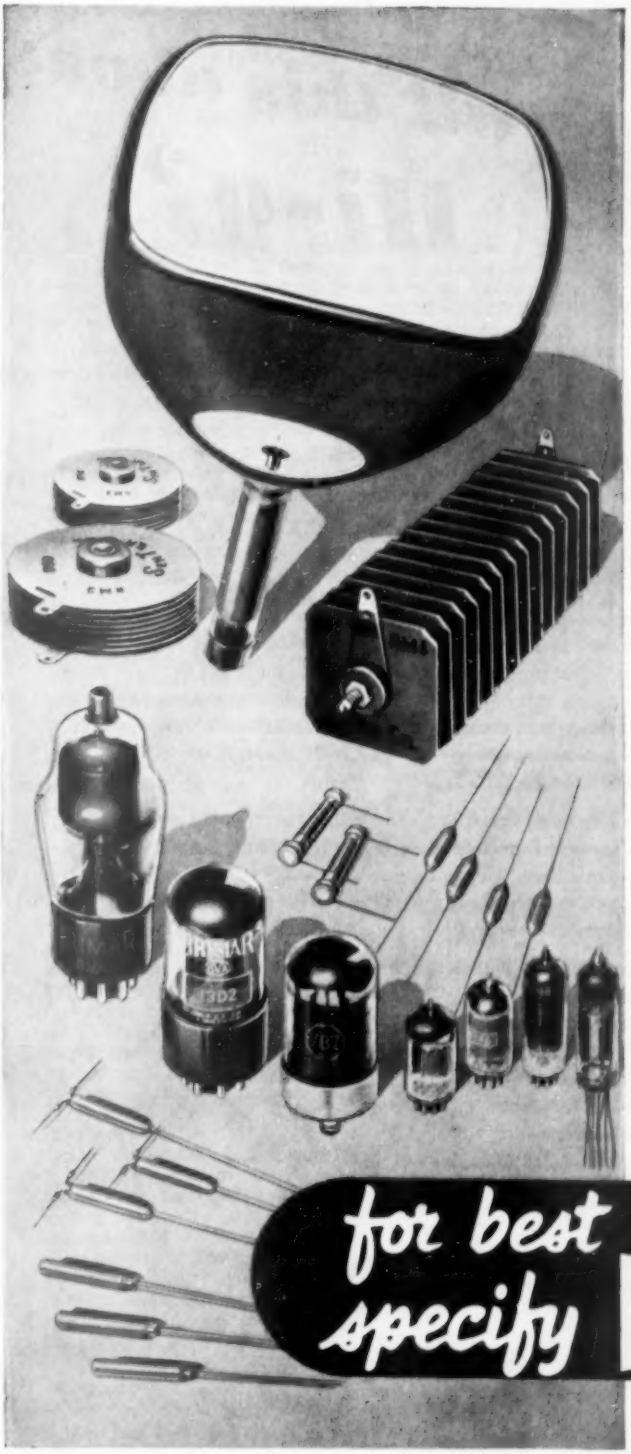
An unusual form of meter movement for pointer instruments was to be found on the Leland stand. It is enclosed in a cylindrical case and is of the Brion Leroux type with the moving coil *outside* the field magnet. It is very compact and the same basic movement is used for all scale sizes.

In addition to a range of measuring apparatus, E.M.I. were showing a new television camera with control desk and associated equipment. The camera is built around a new Emitron tube which is claimed to provide a superior performance. It is of the "cathode potential stabilized" type.

A newcomer in the television camera field is Peto Scott, whose camera was demonstrated by Livingstone Laboratories on a test card. The tube is of the photo-conductive type and results in a very compact and light camera.



A THERMISTOR probe, a bridge circuit and a pointer indicating instrument are the essential parts of this new medical thermometer designed for measuring small changes in skin temperature. Made by the Vibro-Ceramics Corporation of Metuchen, New Jersey, U.S.A., it is said to be instantaneous in operation and to be particularly suitable for measuring capillary temperature, which gives a great deal of information about the circulatory system.



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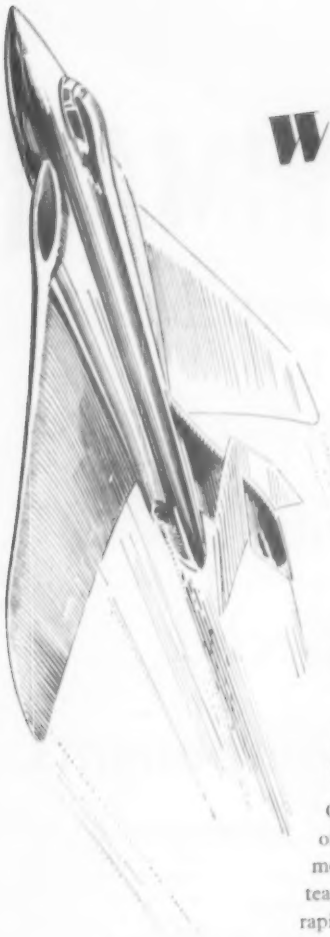

What's all this about Hi-g?

"*g*" is the symbol for acceleration which, to the technical, is defined as the differential of velocity with respect to time. More simply this means the rate of change of speed.

When "*g*" is too great, damage will be done. A locomotive leaves the rails when it takes a curve too fast. At only 6 "*g*", a pilot blacks out when he pulls out of a dive; at 20 "*g*", which is very much more than any plane can possibly encounter, the plane would disintegrate.

The stylus tip of a pick-up is subjected to the same acceleration but to an infinitely greater extent. The undulations of a record groove cause the stylus to vibrate as much as 10,000 times per second or more. It moves to one side of the groove, stops, moves to the other, stops again and so on throughout the record. **The accelerations acting upon the stylus tip are measured in "*g*" and with modern recordings may be well over 1000 "*g*".**

Obviously a light freely suspended stylus will follow rapid changes of direction in record grooves more easily than a heavy, stiffly mounted one. On a heavily recorded record a "stiff" pick-up will tear through record grooves or even jump right out of them. Result: rapid record and stylus wear and poor reproduction.

Correct tracking of modern electrical recordings with their great musical and dynamic range calls for pick-ups specially designed to cope with very high "*g*". They are available, after much patient research and development, under the name "Hi-g". **ACOS "Hi-g" pick-ups perform perfectly at any multiple of "*g*" they are called upon to meet,** representing a truly revolutionary advance in pick-up design. If you want your valuable records to reproduce as well as the makers intended — and to go on doing so for a long time — use an "ACOS Hi-g" pick-up.

(Write for a free copy of the new Cosmocord booklet "The ABC of Hi-g".)

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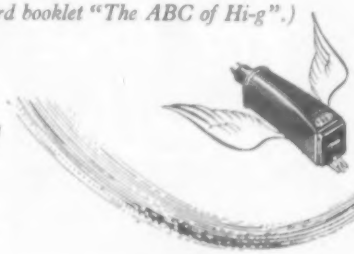

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Phase Shift and Sound Quality

Experiments to Determine How Much Can Be Tolerated

By J. MOIR*, M.I.E.E.

MANY recent amplifier designs have included among their claims to fame in the high-quality sound reproducer field, such statements as "zero phase shift down to 10 c/s or up to 100 kc/s." It is proposed in this article to discuss briefly the meaning of phase shift, to consider the circuit elements responsible and then to examine its effect on the quality of sound reproduced by loudspeakers, to see whether figures for phase shift are worth including in an amplifier specification.

In any circuit that includes a reactive element such as a capacitor or an inductor the alternating current will not reach its maximum value at exactly the same instant as the voltage reaches a maximum. If the circuit includes inductance and resistance only, the current lags, as indicated by the curves of Fig. 1; but if the circuit is composed of capacitance and resistance the current will lead the voltage under steady-state conditions.

The time difference between voltage and current maxima is a significant indication of circuit conditions, but it has become conventional to indicate the time difference not in seconds but as a fraction of the time (period) of one complete cycle at the frequency being considered. Thus the phase shift is one quarter cycle when the circuit is composed entirely of inductance (Fig. 1) or capacitance. Alternatively the difference may be expressed in degrees, and a quarter-cycle phase shift then corresponds to a 90° phase shift. There are other methods of specifying the time difference, but as amplifier designers appear to favour the use of degrees this convention will be generally used in the ensuing discussion. The reasons for the displacement in time of the voltage and current maxima will not be discussed here, our present concern being the final acoustic effects.

The phase shift introduced by a simple circuit of one reactive element and one resistor can never exceed one quarter cycle or ninety degrees, and can only reach this value when the resistor is reduced to zero. The phase difference between voltage and current for a simple combination of resistance and capacitance is plotted in Fig. 2(a) as a function of the ratio of circuit resistance to circuit reactance. This dependence on circuit reactance makes any particular pair of components introduce a phase shift which varies with frequency in exactly the manner shown in Fig. 2(a) if f_o/f is substituted for X_c/R and f/f_o for R/X_c, f being the frequency under consideration and f_o the frequency at which $X_c = R$.

These simple circuits of Fig. 2(b) will be recog-

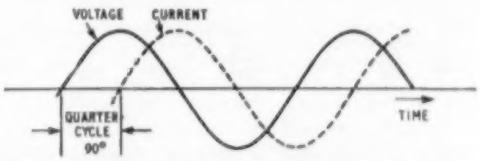
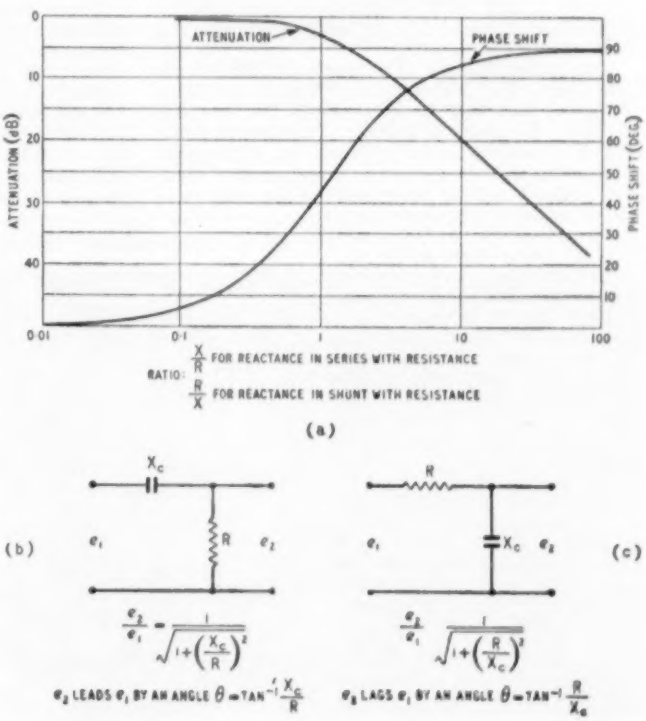


Fig. 1. Conditions in a reactive circuit with voltage and current waves displaced by 90° or one quarter cycle.

Below: Fig. 2. (a) Phase shift and attenuation introduced by single combinations of reactance and resistance such as those at (b) and (c).



* Electronics Engineering Dept., British Thomson-Houston Co., Ltd.

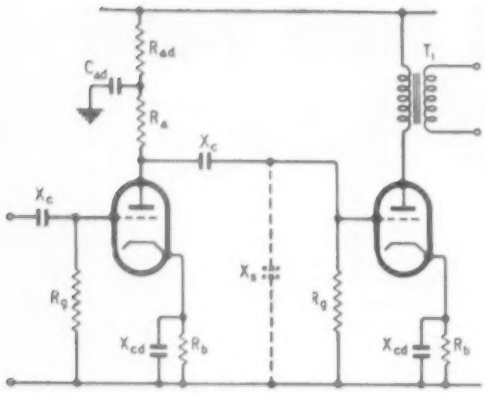


Fig. 3. Elementary amplifier showing sources of phase shift.

X_c and R_g—	Output	voltage	leads	input	voltage	at	low	frequency		
C_{ad} ,, R_{ad}—	,,	,,	lags	,,	,,	,,	,,	,,		
R_b ,, X_{cd}—	,,	,,	leads	,,	,,	,,	,,	,,		
R_a ,, X_s —	,,	,,	lags	,,	,,	,,	high	,,		
T^1 —	,,	,,	leads	,,	,,	,,	low	,,		
—	,,	,,	lags	,,	,,	,,	high	,,		

nized as those used as interstage coupling circuits in RC amplifiers (b) being the grid coupling capacitor and resistor and (c) the anode load resistor with the effective shunt capacitance in parallel with it.

Iron cored devices such as input and output transformers introduce phase shifts at low frequencies of the same order as an RC stage, but may introduce more rapid changes of phase in the region between 30 and 100 kc/s where resonance between the leakage reactance and any stray capacitance can (and usually does) occur.

The circuit diagram of a simple amplifier is reproduced in Fig. 3 showing the circuits responsible for phase shift with an indication of the direction in which the phase is shifted. The overall phase shift is approximately the algebraic sum of the phase shifts of the individual circuits. Application of negative feedback reduces phase shift in the same ratio that it reduces other distortions, a typical result for a high-quality amplifier being shown in Fig. 4.

Though phase shift has been discussed in terms of the difference in time between voltage and current maxima it will be appreciated that this is also the phase difference between the input and output voltages in a circuit such as Fig. 2(b), for the output voltage is in phase with the current in the resistor.

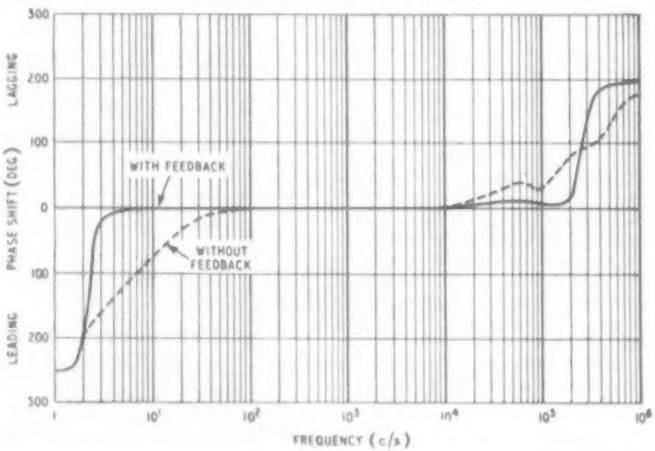
The change of phase with frequency appears to be fairly rapid, even with the simple circuits, but basically it is the change in the *time* of transmission with frequency that introduces waveform distortion. Further investigation shows that the time of transmission between input and output terminals of a network such as Fig. 2(b) is fairly constant at all frequencies at which the circuit attenuation is low. A time of transmission that does not vary with frequency implies a phase-shift/frequency characteristic in which the phase shift is proportional to frequency and not a phase shift that is constant at all frequencies.†

It takes very little consideration to decide that the waveform of a complex wave composed of many frequencies will be drastically distorted in passing through any device in which the time of transmission varies for each of the component frequencies. An example is illustrated in Fig. 5, the output signal on the right, bearing very little resemblance to the square-wave input signal, though all the distortion shown is the result of phase shift and not the result of any frequency-dependent attenuation.

It will be clear that there is considerable difficulty in designing an amplifier (or any other piece of equipment) in which the phase shifts are reduced to zero at all frequencies. If it is considered that waveform distortion must be avoided there are four possible solutions. The first is merely to avoid phase shift completely, a council of perfection. The second is to avoid phase shift within the audio-frequency band of say, 30 to 10,000 c/s. The third solution is the use of a phase/frequency characteristic in which the phase shift in degrees is linearly proportional to frequency, for if this is done all the frequency components are delayed by the same time interval. It is generally of little consequence if a complex signal takes even several milliseconds to pass through an amplifier, provided that all the components take the same time.

The final solution is separately to determine the maximum amount of phase shift that can be allowed before the result is aurally detectable, and then to ensure that the actual phase shift introduced by the system is below this limit. In an extensive audio network this is the only practical solution. The "just detectable" phase shift is a problem that has been the subject of many investigations, but the most authoritative works known to the writer are due to van der Pol of the Philips Research Laboratory and

Fig. 4. Typical phase-shift characteristics of a high-quality domestic amplifier.



† This aspect is developed by "Cathode Ray," whose contribution this month (p. 188) happens to include a discussion of the basic relationships between phase/frequency distortion and amplitude/frequency distortion.—Editor.

Fig. 5. *Effect of phase distortion on a square-wave signal after passing through a reactive network in which there is no variation of attenuation with frequency. Repetition rate, 300 per sec.*

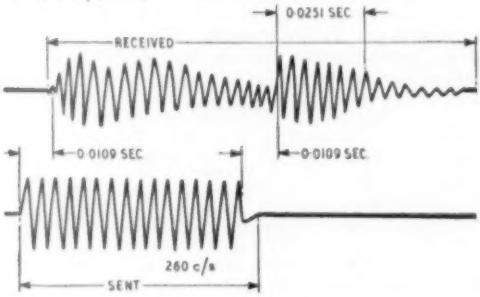


Fig. 6. *Distortion of tone pulse due to phase shift.*

to Steinberg and Lane of the Bell Telephone Laboratories.

Van der Pol made a limited investigation using a special circuit that allowed him to change the phase of the higher harmonics of a complex wave relative to the fundamental by any amount up to 360°. He noted that any phase shift within this limit introduced no effects detectable when listening to speech.

Steinberg and Lane used an experimental technique that permitted much greater amounts of phase shift to be introduced into the reproducer system. Low-pass or high-pass filters of the normal ladder type introduce appreciable amounts of phase shift near the ends of the transmitted range. Filters of this kind may be added in series to produce any desired amount of shift at any point in the frequency range. The "just detectable" amount of phase shift proved to be so large that it is more convenient and indeed more indicative of the mechanism to express the shift in milliseconds.

To produce effects detectable on speech it was found necessary to shift the frequency components in the 5-8 kc/s band by about 8 milliseconds relative to the 1 kc/s components. Frequency components in the 50-100 c/s region had to be shifted by as much as 70 milliseconds before the effect was detectable. These time differences correspond to a relative phase shift of 64 complete cycles or 23,000 degrees at 8 kc/s and to a shift of 7 complete cycles or 2,520 degrees at 100 c/s.

Delays of this order are recognized as separate hollow ringing echoes, an effect often heard on long telephone lines and somewhat akin to acoustic reverberation.

The electrical effects can be demonstrated by injecting short pulses of tone into the equipment under test. The transmitted and a typical received signal are shown in Fig 6 (based on Fig. 10, p. 503, *B.S.T.J.*, Vol. 9, 1930) for a filter having a time delay of 0.01 seconds, and it will be seen that both head and tail of the transmitted pulse are badly distorted, the pulse being stretched until the received pulse is almost twice as long as the transmitted pulse.

Reference to Fig. 4 will remind the reader that an ordinary amplifier of the type likely to be used by the high-quality enthusiast is more likely to have phase shifts of a few degrees, quite innocuous in comparison with the phase shifts found necessary to produce audible distortion.

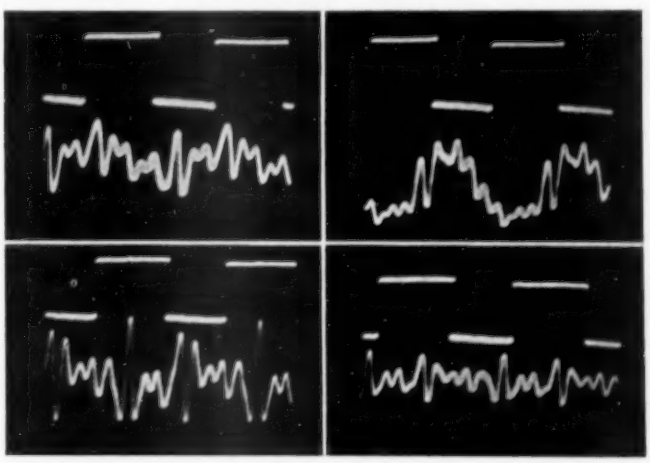
To the best of the writer's knowledge these results remain as authoritative, no subsequent investigation having thrown the slightest suspicion on the results of van der Pol, Lane and Steinberg.

It is commonly stated that though phase shift may not have much effect on the quality of steady tones it does have a much greater effect on the quality of transients. Steinberg did in fact comment upon this point, noting that phase distortion was much more objectionable on speech than on music. However, the minimum detectable phase shifts quoted earlier are the figures obtained from tests on speech. Though transient in nature, speech may not represent the ultimate in this respect so that to gain some personal experience tests were instituted using square waves.

A high-quality reproducer system was set up employing amplifiers capable of passing square waves without perceptible waveform distortion when the output signal at the speaker terminals was viewed on an oscilloscope. Loudspeakers may be the weak link, but those used were representative of the highest quality currently available, several different types having been employed at different times.

The input signal was the square wave shown in Fig. 5, lattice all-pass filters being employed to introduce phase shift without any frequency-dependent attenuation. The result of introducing phase shift

Fig. 7. *The lower traces are the acoustic waveforms at points on or near the axis and at distances not more than 3ft from the diaphragm of a loudspeaker to which a square voltage wave has been applied. Repetition rate 900 per sec.*



was to convert the waveform of Fig. 5(a) into that of Fig. 5(b) but even this drastic change could not be detected by any member of an experienced listening crew. The equipment has subsequently been used as a demonstration at several lectures, but to date, no listener has ever claimed to be able to detect the difference between the two waves.

This cannot be claimed as an absolutely conclusive test for there are an infinite variety of transient waveforms and it will always be impossible to claim that all have been tested; but taken in conjunction with other results it does suggest that phase shift is certainly not of great importance and may not be of any importance. This point of view has been confirmed in private communication with other workers on the subject.

When the results of laboratory tests appear to contradict common sense it is always worth looking round for confirmation or contradiction from everyday experience. A little consideration of the acoustic conditions in any concert hall will suggest that it is perhaps providential that our sensitivity to phase shift is low.

Sound from any source, original or a reproduction, reaches the listener first by the direct and shortest path and then by successive reflections along paths of increasing length. At listening positions only a few inches apart the acoustic pressure pattern in space varies enormously as different reflection paths of varying length become of predominating importance, and yet the sound quality remains unaltered. This is illustrated by the oscillograms of Fig. 7 indicating the changes in acoustic waveform at points a foot or so apart when a square wave (voltage) is impressed on the loudspeaker terminals. At some points the acoustic pressure waveform approximates that of the electrical signal but at other points there is little resemblance to a square wave. All the check points were on or close to the speaker axis and not more than three feet from the speaker.

Current loudspeaker designs provide another simple indication of the unimportance of phase shift in small amounts. In the sound reproducer field many of the loudspeakers having the highest reputation consist of units radiating the high frequency components either directly from the front of the cone or via a short straight horn, while the low frequency components below perhaps 500 c/s are radiated from the rear of the cone through a long folded horn. The difference in path length traversed by the low and high frequency components may amount to 5-8 feet (5-8 milliseconds, about 360 degrees at 150 c/s) and yet loudspeakers of this type such as the Lowther, Tannoy and Klipschorn have an acknowledged reputation for quality of reproduction.

Quite clearly the evidence suggests that phase shift does not have the importance usually attached to it by the high quality enthusiast. The phase shift introduced by any amplifier of normal design is so low in comparison with the minimum detectable phase shift that it is hardly worth considering. A broadcasting or telephone administration operating an extensive interconnection system that might involve 80-100 amplifiers connected in series would, however, have to pay a little more attention to the phase shift introduced by the individual amplifiers in order to keep the total shift below the minimum detectable figure. Even in this instance the audible effects of phase shift are usually due to shifts introduced by filters or by the line itself near the ends of the transmitted frequency band and are not due to the amplifiers.

This discussion suggests that the phase shift introduced by a domestic amplifier is of little consequence as an indication of the quality of reproduction and is not really worth quoting. Phase shift is of importance when considering the stability of an amplifier with feedback but this is an entirely different matter.

It is perhaps an indication of the omnipotence of nature that she has developed a hearing system that is insensitive to phase shift.

Thanks are due to Chapman and Hall for permission to use the diagrams taken from the writer's book "High Quality Sound Reproduction" to be published shortly.

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"Motion Picture Sound Engineering," Chapter 13, (Chapman and Hall).

BOOKS RECEIVED

The Services Textbook of Radio: Vol. 3.—Electronics by J. Thomson, M.A., D.Sc., F.Inst.P., M.I.E.E. Edited by the technical staff of *Wireless World*. One of a series of seven volumes issued jointly by the Admiralty, the War Office and the Air Ministry for the instruction of beginners and as a standard work of reference for technicians in civil life as well as in the Services. Deals primarily with the thermionic valve in all its forms and includes chapters on semi-conductors, photo-electric devices, electron optics and cathode-ray tubes. Pp. 259+ix; Figs. 218. Price 12s 6d. Her Majesty's Stationery Office, York House, Kingsway, London, W.C.2.

Fundamentals of Television Engineering by Glenn M. Glasford. Comprehensive analysis of television system design problems from the camera tube to the receiver display, in which alternative solutions are considered from both the theoretical and the technically realizable standpoint. Colour and monochrome are dealt with concurrently and circuit analysis makes full use of the transform calculus. Pp. 642+xiv; Figs. 567. Price 71s 6d. McGraw Hill Publishing Company, Ltd., 95, Farringdon Street, London, E.C.4.

Metal Transfer between Palladium and Silver Contacts at Low Inductances by J. Riddlestone, B.A. E.R.A. Technical Report U/T133 on the nature and extent of erosion and accretion in contacts breaking currents from 3 to 15A at 6V in circuits with inductance between 0.07 and 96μH. Pp. 21; Figs. 12. Price 12s 10d by post. The Electrical Research Association, Thorncroft Manor, Dorking Road, Leatherhead, Surrey.

Electrical Who's Who, 1956-57. Brief biographies of leading members of the professional and industrial branches of the industry, including telecommunications, together with lists classified under the titles of firms and organizations. Pp. 454. Price 21s. Electrical Review Publications, Ltd., Dorset House, Stamford Street, London, S.E.1.

British Plastics Year Book, 1956. Classified guide to products and manufacturers giving addresses of 4,000 firms in 50 countries. Includes buyers' guide to materials and plant, a review of recent plastics patents, a glossary of terms and lists of proprietary names, trade associations, etc. Pp. 740. Price 35s. Iliffe and Sons, Ltd., Dorset House, Stamford Street, London, S.E.1.

TELEVISION AT U.H.F.

PROPAGATION PROBLEMS IN BANDS IV AND V

THE success of the future expansion of television broadcasting in this country depends to a marked extent upon the ability to exploit the internationally allocated Bands IV and V, covering the frequency ranges of 470 to 585 and 610 to 960 Mc/s, respectively. Apart from the problems of developing high-power transmitters and sensitive noise-free receivers to operate on these frequencies, it is most important to have a clear and detailed knowledge of the propagation of the radio waves involved. This propagation will determine, on the one hand, the service areas of the transmitters and, on the other, the possibilities of interference from other stations whether engaged in the same or different services.

In a paper* read before the Television Society in March, Dr. R. L. Smith-Rose reviewed the present state of knowledge of u.h.f. propagation, particularly in so far as the future possibilities of television services in Bands IV and V are concerned. Dr. Smith-Rose and his collaborators, Dr. J. A. Saxton and J. A. Lane, have already published in *Wireless World*† and elsewhere a good deal on this subject and this material was drawn upon for the lecture. Having dealt in general with the theory of u.h.f. propagation over "smooth earth" and over irregular terrain, the lecturer concluded with some practical results with television transmitters operating in the u.h.f. band.

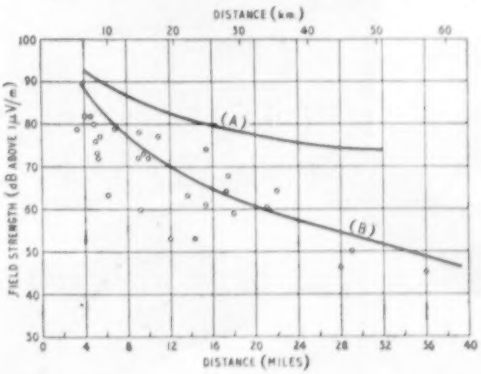
Some experience in this direction has already been obtained in the United States where a number of experimental television stations operating in the u.h.f. band have been set up during the past few years. Early experiments by the Radio Corporation of America have emphasized that it is important that the transmitting aerial system should be as high as possible above the surrounding terrain. A full-scale investigation has therefore been conducted with station KPTV, at Portland, Oregon, where the main populated area to be served is relatively flat and lies in a valley between two mountain ranges. The transmitting aerial at this station was installed on a ridge to one side of the town and at a height of about 1,000ft above it.

The transmitter operates in the American frequency channel No. 27 (548 to 554 Mc/s). Its output power is one kilowatt fed to a slot aerial installed on top of a 200ft tower. This would give a power gain of 21 in the horizontal plane, but the aerial is mechanically tilted forward about 1 degree towards the populous city area, and it is electrically adjusted to increase the signal radiated in what would otherwise be a "null" in the radiation pattern. The resulting effective radiated power is 16 kW.

Measurements have been made with a mobile receiver of the field strength obtained in four radial directions from this transmitter out to distances of more than 30 miles. The results calculated on an e.r.p. of 1 kW are reproduced in the diagram on which are drawn curves for the free space radiation (A) and for the median conditions for 50% of locations and 50% of time (B) recommended by the F.C.C. for operation in this frequency channel. It will be seen that the measured values lie reasonably along this median curve although there is a spread among the observed values, particularly at the shorter ranges. Somewhat similar results have been obtained at three other stations at South Bend (Indiana), York (Philadelphia) and Atlantic City (New Jersey) on frequencies which range from 590 to over 700 Mc/s. In all cases, the median curve is followed, but there are conspicuous shadow areas where the field strength may range over ±10 dB about this curve.

Field strength contours for the Portland transmitter show a constriction between mountains enclosing the valley, and also the existence of "dead" spots where reception of signals is very difficult indeed; these comprise about 5% of the built-up city and 12% of the whole residential area. However, the transmitter will furnish a good service to 88% of the population in the Portland area, and this could be increased to about 94% by increasing the effective radiated power to between 100 and 200 kW, or about ten times the present value. On this basis it is considered that in such favourable locations the use of u.h.f. for television can compare very well with v.h.f. although it may require ten times as much transmitter power to cover the same area.

Apart from propagation studies, the experience obtained at Portland has provided a good deal of information on the performance of receivers used with the type of aerials to be normally provided for u.h.f. reception. The limit to the reception of good television pictures is set by the noise level of the input circuits of the receiver, this noise being



Measured field strength along four radials from transmitter KPTV at Portland, U.S.A.

* "Radio Wave Propagation and the Problems of Television Bands IV and V."

† *Wireless World*, May and July 1955.

responsible for what is termed "snow" on the screen of the cathode-ray tube. Actual observations showed that under these conditions a good picture was obtained with a field strength of 2mV/m (66dB above 1 μV/m); and this would appear to agree favourably with the target which has been set by the F.C.C. at 1.6 mV/m (64 dB above 1 μV/m for the class B service). For the first-class or A service, the required signal should be 10 dB greater (74 dB above 1 μV/m). It seems likely that in due course these conditions will be met by the use of effective radiated powers well within the limit of 1,000 kW set by the F.C.C.

As a final word of warning, however, Dr. Smith-Rose said there is still much to be learnt about the phenomena of propagation on these higher frequencies. The possibilities of multi-path transmission, in which two or more waves may reach a receiving aerial with resulting complex interference patterns, are likely to add to the difficulties of the so-called "dead" areas of reception. There is also the subject of the effect of varying weather conditions on propagation through the troposphere. In this case, the effects observed are unlikely to be serious at service ranges of 20 to 30 miles; but, as was the case for v.h.f. propagation, a knowledge of these tropospheric effects is essential before plans involving the sharing of frequency channels by stations in different localities are drawn up. These are among the problems requiring further investigation as the development of u.h.f. for television transmission proceeds.

Manufacturers' Products

NEW EQUIPMENT AND ACCESSORIES FOR RADIO AND ELECTRONICS

Mobile Radio

THE illustration shows the new mobile radio v.h.f. equipment introduced by Murphy Radio. The unit partly withdrawn from its case is the transmitter-receiver chassis of the mobile set, Type MR800, while the larger self-contained set is the Type MR862 for fixed stations. A separate 6- or 12-volt vibrator-type power unit is used for the mobile set as this allows greater flexibility in installation.

Controls on both sets are reduced to a minimum and on the mobile they comprise only an on-off switch (with receive and stand-by positions), volume control and send-receive switch on the microphone or handset. Transmitter and receiver are crystal controlled and can be set up on any single frequency in one of the three bands 60 to 90 Mc/s, 100 to 133 Mc/s or 133 to 174 Mc/s. The receiver is a double super-heterodyne.

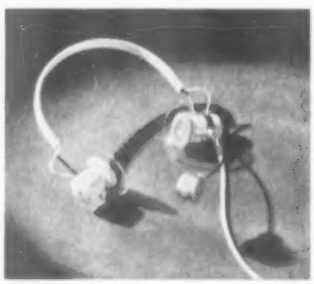
The self-contained fixed station set measures 22in × 11in × 10in and it employs the same r.f. chassis as the mobile set but modified to provide a slightly larger r.f. power output, muting circuits and remote control equipment. It is a.c. operated. The normal controls comprise volume, on-off switch, muting and meter selection switch for monitoring purposes, with the send-receiver switch on the microphone stand (or remote control unit when used). Provision is made for remote control over internal or external G.P.O. lines. In the illustration the front panel surround is removed revealing two sets of subsidiary controls for setting-up and change in frequency. With a suitable transmitting aerial a working range of 15 miles or more is possible.

The makers are Murphy Radio, Ltd., Welwyn Garden City, Herts, and the prices are £85 for the mobile and £150 for the fixed station set.

Murphy mobile and fixed station radio-telephone equipment.

Lightweight Headset

WEIGHING only 7oz, the Type 2566 headsets made by the Industrial Products Division of Amplivox, Ltd., 2, Bentinck Street, London, W.1, are designed to minimize fatigue when worn for long periods. They have in fact been adopted for use in the control towers of airfields under the administration of the Ministry of Transport and Civil Aviation.

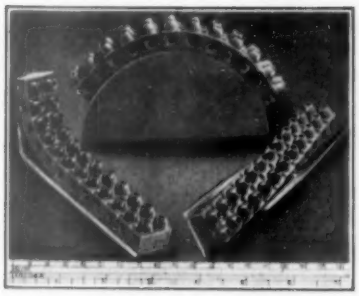


Flexibly mounted Perspex ear discs are a feature of the Amplivox lightweight headphone microphone sets.

Electro-magnetic insert units for the earpieces have acoustically equalized response within ±3 dB from 200 c/s to 3,300 c/s. Three types of microphone insert, including a differential noise-cancelling model, are available.

U.H.F. Communications Receiver

IN the description of the Eddystone 770U receiver on page 118 in our March issue the bandwith was given as 15 kc/s whereas this is the kc/s-off-resonance figure at the 3-dB points. The corresponding bandwidth is therefore 30 kc/s.



"BELLING-LEE"

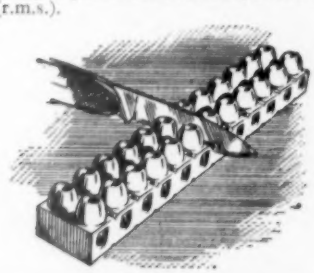
FLEXIBLE TERMINAL BLOCK

U.K. Patent 680406

This unique component was designed to provide great flexibility in both planes, thus enabling it to be secured to curves or irregular surfaces. It is moulded in P.V.C., which securely grips the terminal screws so that they cannot fall out **even if totally unscrewed from their inserts and the block mounted upside down.**

The block is mechanically shock-proof and can easily be sub-divided with an ordinary knife into smaller groups of terminals. Fixing holes provided for each pair of terminals.

L.744 is a 12-way strip, rated at 5amp., but may be used at the designer's discretion up to 10 amp., or up to 2 kV. peak working voltage between terminals or between terminals or chassis. Overall size, 5in. × .750in. × .625in. high. Hole centres spaced .425in. L.1325 is a new larger version, rated at 15 amp., and conforms with safety requirements B.S.A.15, at 500 v. (r.m.s.).



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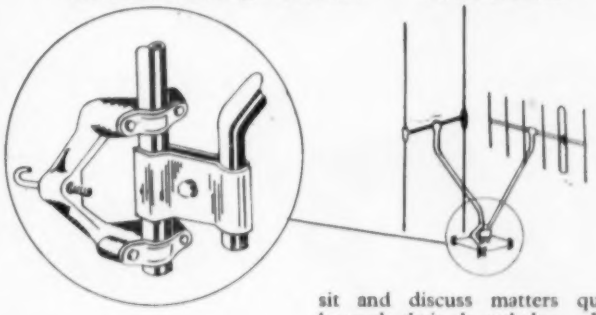
"BELLING-LEE" NOTES



The Last Straw.

Now that I.T.V. is beginning to influence the skyline in many parts of the country, some alarming sights can be seen. In one town, midway between London and Birmingham, there is a nine-element band III array on a 12-foot mast clamped precariously on top of a "Multirod" with handcuff clamps. Now the "Multirod" is designed to stand up to gusts of 80 m.p.h. It is alleged to have withstood 125 m.p.h. But if a gale hits this combined erection the whole lot will come down. It doesn't stand a chance.

"Belling-Lee" design their aerials to be stronger than most, as every dealer in exposed locations knows. But economics prohibit any firm manufacturing aerials so strong that additional arrays may be added without careful thought to wind resistances.

Unless combined aerials or independently mounted band I and band III aerials are being used we recommend the L.903/BS and L.904/BS (illustrated above) for their durability and sensitivity. The illustration shows in detail the original bracket and the special adaptor clamp. In this way none of the original bolts need be disturbed, seizing up troubles do not exist, and the band III array may be orientated as required.

When a band III aerial is required to be attached to a vertical mast, the 3, 6 and 9-element adaptors are available with stacking clamps for fixing on the band I mast, below the array.

The Fact of the Matter.

Every now and again some local body decides to have a blitz on T.V. aerials and committees sit and discuss matters quite beyond their knowledge. Recently we heard of a case where only "Multirod" aerials were permissible so that four flat dwellers may share the one high gain aerial rather than have four "H" type aerials on the roof. It is incidental that the district is one where many of the viewers require a "Multirod" in any case, if a tolerable picture is required.

Now where an aerial is being shared, it is necessary to "pad" off the "subscribers" with a star network that has an inevitable loss of 6 dB per point, i.e., the loss with all the viewers switched on, is in the region of 24 dB. The difference in gain between an "H" aerial and a "Multirod" is about 6 dB. only. No comment.

Advertisement of
BELLING & LEE LTD.
Great Cambridge Rd., Enfield, Middx.
Written 5th March, 1956

See what you measure . . .
. . . measure what you see

Pulse Base at cursor voltmeter reads 0 volts

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Measured Pulse amplitude 4 volts

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LETTERS TO THE EDITOR

The Editor does not necessarily endorse the opinions expressed by his correspondents

Disc Playback Characteristics

THERE have recently appeared an entirely new crop of gramophone recording (playback) characteristic titles:

(a) R.C.A. "New Orthophonic."
(b) New A.E.S. (January, 1954).
(c) R.I.A.A.
(d) N.A.R.T.B. (June, 1953).
(e) B.S. 1928:1955.
(f) C.C.I.R. } Proposed revisions
(b) I.E.C. } to be confirmed.

All these authorities specify a fine groove characteristic, and they are all identical. Some also specify a coarse groove characteristic and again they are all identical. These two characteristics are now used by nearly all the major manufacturers throughout the world and they may therefore be taken as international standards. All that remains is to standardize the title, preferably in some short form that may be easily fitted around the periphery of a record equalizer selector knob together with the older characteristics.

None of the titles given above is ideal, either because they may not be internationally known or are cumbersome. (Or both; imagine a switch position labelled "British Standard 1928:1955 Fine Groove.") Simplification to "LP" and "78" fails to distinguish between a wide variety of earlier characteristics and does not apparently allow 45-r.p.m. records to be played, not to speak of complications with fine-groove 78-r.p.m. records. Another possible solution is to use the terms "FINE" and "COARSE." The operator of the gramophone will then fall into one of four groups. First, those who know; secondly, those who try to measure the width of the groove with a 12-in rule; thirdly, those who think it refers to the song on the record rather than the groove; and, fourthly, those who do not understand English anyway.

The most logical solution seems to lie in an extension of the Red Triangle, Green Square system (B.S. 1928: 1955). This at present may be used on transcription record labels and on pickup heads to indicate fine groove or coarse groove. Used also as an equalizer switch position marking, it forms the basis of a simple unambiguous system, free from language difficulties.

For example, if the record label bears the symbol

(preferably in red), it conveys the following information:

(a) The recording characteristic used is that recommended for fine groove records in B.S. 1928:1955 or equivalent.

(b) The turntable should revolve at 45 r.p.m.

(c) The pickup head should bear the red triangle symbol (or in the case of turn-over types, be set so that the symbol is visible), i.e., the stylus tip radius should be 0.001in.

(d) The equalizer switch should be set to the red triangle position in order to select the correct playback compensation.

Huntingdon. JOHN D. COLLINSON.

Single or Double Sideband?

THE decision to open the Crystal Palace Television station on a vestigial sideband basis was taken, states the B.B.C., after consultation with the G.P.O., the Radio Industry, and the Trade. The viewing public was not apparently consulted.

The arguments against such a decision are:—

1. The change makes a large number of receivers obsolete.

2. The channel space saved is jammed in between two channels in a band allocated exclusively to television and is, therefore, unlikely to be used for anything else.

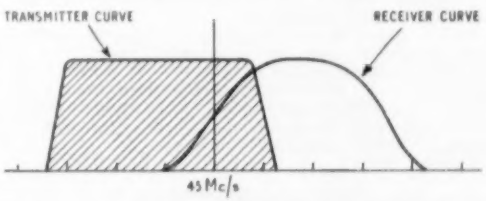
3. Sentimentally there is a case for retaining for as long as possible (and at least until there are no receivers using both sidebands) the superior performance possible with double sideband operation in this special case of the world's first high-definition television service.

4. The change can be made easily at any time in the future.

The modification necessary to the double sideband receiver is not too difficult but the modification to the upper sideband receiver is extremely difficult, involving as it does a complete new tuning set-up over several stages and the inclusion of two or more sound rejection circuits. In the B.B.C. statement to the Press dated March 8th, 1956, these latter receivers are dealt with as follows.

"In a few cases, some modifications to the receiver may be advisable and there may be some slight loss of detail in the picture." This is a masterpiece of understatement.

In the diagram below the shaded area represents the



information sent by a vestigial sideband transmitter. The full line curve shows the reception capability of upper sideband receivers. The area under this receiver curve outside the shaded area represents what is described as the slight loss of detail. If such a "slight loss" occurred in apparatus for the B.B.C. instead of for the public, the B.B.C. would undoubtedly describe the loss of information as serious and unacceptable.

In a classic paper by Sir Noel Ashbridge in 1951*, on the British Television Service, he says "Consideration has been given to modifying the characteristics of the Alexandra Palace transmitter so that this, too, could radiate only one vision sideband. At the time of consideration the number of receiving sets in use was of the order of 60,000; it was decided that it would be unfair to the owners of these sets to change the characteristics of transmission."

These sentiments are admirable but it would seem that the same situation today has not received the same consideration.

"LAMBDA."

* Proceedings of the Joint Engineering Conference, 1951, Part II, page 491.

Ionospheric Scattering at V.H.F.

DR. SAXTON'S article in your January issue is timely —if disappointing. As would be expected from the author, his treatment of the subject is scientific and logical. No one will quarrel with this approach, except perhaps that enough acknowledgment is not given to the great effort put into the study and development of scatter techniques in North America in the last few years.

As you read the article, you get a growing impression

that ionospheric scatter is still largely experimental, and the final section on "Application to Communications" damns the whole subject with such phrases as "unlikely to be satisfactory," or when dealing with telephony—"impracticable transmitter power." It ends with the inference that when an aurora occurs a scatter link becomes "practically impossible"—a generalization which is almost certain to prove untrue.

The Proceedings of the recent Convention of the U.S. Institute of Radio Engineers on scatter give an almost overwhelming volume of information on the subject; in particular an account is given of six circuits in America, Greenland and the Azores which have been operated experimentally using ionospheric scatter over a considerable period. One terminal situated at Sondre Stromfjord, in Greenland (in a region of high aurora activity), appears to have worked Goose Bay satisfactorily over a period of 3½ years. There are, of course, no published figures of the performance of the operational circuits subsequently established, but the fact is that the U.S. Forces *have* decided to use ionospheric scatter operationally and they will clearly not be satisfied with the very few channels and frequent interruptions that Dr. Saxton expects.

Furthermore, a number of U.S. and Canadian manufacturers and consultants are prepared both to erect ionospheric and tropospheric scatter links or to work out the parameters for the customer who is prepared to do the job himself. They are quick to point out the advantages of such links, such as their reliability and the elimination of frequency changing. In the case of tropospheric scatter very large bandwidths can be handled over short distances.

V.H.F. scatter is not the answer to all communications headaches, and the ionospheric variety has a somewhat limited field of application. However, I do urge that it is time we stopped looking on scatter circuits as a difficult experimental feat; they are already operational, and we in this country are in danger of being left farther and farther behind.

London, W.1. C. S. CADELL.

"*Precision Photographic Timer*"

WE have studied with interest the circuit described by J. G. Thomason in the February issue as we have ourselves used the Miller integrator for timing precisely intervals of the order of 15 minutes. The use of a Miller integrator in this way, in conjunction with a gas-filled triode, is covered by British Patent 613,565.

In practice, it is difficult to realize any advantage from the use of a Miller integrator. Valve ageing and supply voltage variations produce changes in the internal gain and hence in the effective CR product. The most consistent results are obtained when the charging voltage $(e_{in}-e_a)$, is high and reckoned in tens, or preferably hundreds, of volts. Mr. Thomason has shown that, in order to obtain a useful amplification of CR, it is, in practice, necessary to reduce e_{in} to a few volts. In consequence small variations in e_a (due to changes in contact potential between grid and cathode) have a significant effect on the time interval.

For these reasons we prefer to use a cold-cathode trigger tube in the type of circuit shown on page 177 of the April, 1955 issue of *Wireless World*. The economy of this simple circuit more than offsets the higher cost of the relatively large timing capacitor required. Using a 12-μF capacitor, long exposure times may be obtained with comparatively low (and hence stable) timing resistors by using a 2.2-megohm variable resistor in series with a number of 2.2-megohm fixed resistors. As each fixed resistor is brought into circuit by a step switch, the exposure time is increased by 15 seconds. This arrangement has the advantage of allowing exposure adjustments by increments smaller than the $\sqrt{2}$ steps suggested by Mr. Thomason.

We also have used a non-linear resistor such as "Atmite" for exposure compensation, though in a different circuit arrangement. Our experience has been that its value for this type of work is limited by its high temperature coefficient.

The single-valve circuit referred to above appears preferable on grounds of simplicity, economy, stability, elimination of warming-up period and the wide range of supply voltages over which accurate compensation is provided. This circuit is protected by British Patents 656,275 and 667,296.

Ilford, Limited, R. J. HERCOCK.
Watford, Herts. D. M. NEALE.

J. G. THOMASON states (your February issue) that the anode should not be started at the full H.T. voltage, or initially there would be no voltage drop across the anode load resistor, no anode current, and therefore no gain. Actually there is no need for an "anode load" at all. If the anode load is disconnected, the capacitor will still commence discharging through the valve as soon as the relay contact A1 is opened, and the rate of discharge will be almost independent of any change in the H.T. voltage during the timing interval. The effective time constant will be:—

$$C(r_a + R[1+\mu]).$$

Satisfactory operation will depend on whether the amplification factor of an EF37 is sufficient when the anode current is reduced to 1μA. This will have to be determined by experiment unless constant-current curves are available.

Twickenham, Middx. G. A. ASKEW.

Future of European Broadcasting

I WAS most interested to read G. H. Russell's article in the January issue on the replanning of the long and medium wavebands.

While his proposals—if they could be put into effect—would undoubtedly improve matters a great deal, I believe that they are open to two serious criticisms:

(1) One of his factors controlling allocations is "population"; surely this ought to be "number of receivers in use."

(2) I do not consider that international reception will be satisfactory, by modern standards, so long as the present 9-kc/s separation is retained. The shifting of local services to v.h.f. should eventually make it possible to use a separation of, say, 15 kc/s, for at least part of the medium wavebands, to be used by one station in each country, transmitting an "international" programme.

Hindhead, Surrey. G. H. STURGE.

Non-linearity

IN the January issue of *Wireless Engineer* the Editor refutes statements he has seen to the effect that distortion due to non-linearity cannot be eliminated by opposite non-linearity. I have an uncomfortable feeling that this dunce's cap fits me, for having said (on p. 317 of your July, 1955 issue), "Unlike frequency distortion, the results of non-linearity in one unit of the audio chain cannot be compensated by opposite non-linearity in another." However, it is pretty clear from the *Wireless Engineer* Editorial that compensation of non-linearity is mainly if not entirely of academic interest and is unlikely to be of practical value even within a single unit, such as an amplifier, let alone between one unit and another, such as amplifier and loudspeaker. I doubt whether the Editor could seriously disagree with my statement within the limits of its context. Nevertheless on a point of strict accuracy I readily plead guilty, with acknowledgments to *Wireless Engineer*, and ask that the words "in normal practice" be understood after "cannot."

Bromley. M. G. SCROGGIE.

Burne-Jones "Super 90" Pickup Arm. The price of this component is £11 11s plus £4 12s 5d tax and not £16 9s as stated on p. 119 of the March issue.

More Lines for Colour?

By V. J. COOPER,* B.Sc.(Eng.), A.C.G.I., M.I.E.E., M.Brit.I.R.E.

AN OLD TELEVISION CONTROVERSY BROUGHT UP TO DATE

THE glamour of more lines for our television pictures is once again being widely discussed and from some quarters comes the suggestion that we should adopt a 625-line system for colour television in Bands IV and V. Do we need more lines, and if we have them shall we get better pictures? These are the questions that the viewing public ask and usually expect an affirmative answer; for the number of lines in the picture structure is a property that all can appreciate, and, on first thoughts, the more the lines the better the picture. What is frequently overlooked, in a casual examination of the problem, is the fact that picture quality for a given fixed total information content in the picture is not just a matter of lines. During the past few months the technical press in U.S.A. has made several references to the better pictures we receive in our homes in Britain compared with those received in American homes: yet the Americans have 525 lines and we have only 405.

The difference could be due to a variety of causes, for example, camera control, amplitude linearity response, synchronizing stability, black level stability, apparent resolution, etc. One fact that may be contributory is that the possible horizontal resolution expressed as a fraction of the possible vertical resolution of the 405-line system, using 3 Mc/s bandwidth, is markedly superior to that for the 525-line system using 4 Mc/s bandwidth.

The superiority of the horizontal resolution in our system over that of U.S.A. standards, expressed in round figures on this basis, is about 45 per cent. It would appear that no one has so far published a subjectively derived figure for the optimum ratio of horizontal to vertical resolution, but on the evidence that exists it would seem that in this country we may be nearer the optimum than the Americans.

Let us for a moment consider one of the fundamental requirements in a television picture; the acknowledged requirement that the picture should be wider than it is high—why is this so?

Nature has given us eyes which are laterally spaced. This results in our having the property of vision perspective in the horizontal plane. We therefore appreciate more information that is presented horizontally. By and large, our world spreads around us laterally and the great majority of movement and interest is horizontal. Cinemascope, Vistavision and the other new forms of picture presentation underline this human tendency to enjoy more breadth of vision than height of vision.

It would seem fantastic if cinema screens were made high and narrow instead of wide and shallow. If further proof be needed, the simple experiment of breaking up a line of typescript characters by horizontal lines and a similar line of typescript by vertical lines so that individual letters are mutilated, will demonstrate that as long as horizontal continuity is preserved the words are much more easily read than when horizontal continuity is destroyed.

The conclusion to be drawn so far, therefore, is that we must preserve horizontal continuity and extend the amount of information horizontally. Fink† suggests that we can usefully extend horizontal information by 50 per cent and this is confirmed in a *Wireless World* article.‡

How do these requirements fit into a television system? The basic factor of television transmission is that the maximum amount of information that can be sent is a function of the bandwidth of the system. In this country, for the 405-line system we use a picture bandwidth of 3 Mc/s; in the U.S.A., for 525 lines, about 4 Mc/s is used, and in Europe, for 625 lines, about 5 Mc/s.

A Limited Commodity

Bandwidth of transmission is directly related to the number of stations that can be operated in a given band of assigned frequencies. Thus for 3-Mc/s vision band transmissions we can have more channels than the U.S.A. or Europe, or conversely for a given number of channels we need less bandwidth in the radio frequency spectrum.

This is a highly important consideration. R.F. bandwidth available in the foreseeable future is the one commodity in which we are definitely limited. It is, in fact, our capital asset in a bank which for the next 50 years at any rate will not be able to offer overdraft facilities. It is therefore foolish to dissipate this capital asset more rapidly than absolutely necessary. If to-day we use all the available bandwidth, the next generation will find expansion of radio services the more difficult. The conclusion to be drawn, surely, is that the best possible reasons should be forthcoming for any suggestion that bandwidth per channel should be increased. We should, on the other hand, be more concerned with reducing bandwidths used consistent with maintaining a reasonable service.

For a radio service providing entertainment, the use of 3 Mc/s for a vision channel is already outrageous—it occupies over 100 times the bandwidth of the accompanying high-quality sound channel and in terms of value for value the ratio is even greater. This statement is readily acceptable if one conducts the test of (a) looking at television with the sound off, (b) listening to the sound with no vision. The vision information on its own is far less valuable as entertainment than the sound by itself.

We are still a long way from achieving bandwidth reduction without sacrificing picture quality in

* Marconi's Wireless Telegraph Company.

† "Principles of Television Engineering," Donald G. Fink, McGraw-Hill Book Company Inc. 1940.

‡ "Television Standards," *Wireless World*, Oct. 1948, p. 382, col. 1, line 20.

broadcast systems, although the present generation may, by the use of coding, achieve progress in this direction on closed-circuit systems. If we cannot reduce broadcast service bandwidths then at least we should conserve them, and this thought makes the possibility of using more lines far less attractive.

More lines means more bandwidth in transmitters, receivers and link systems and this inevitably means greater cost.

Consequences of 625 Lines

To achieve a significant improvement in picture quality for, say, large-screen operation we should need to adopt, say, 625 lines, and to preserve the same ratio of horizontal to vertical resolution we should need a bandwidth of over 6 Mc/s. This is considerably beyond the basis of the European C.C.I.R. standards, which have a 5-Mc/s video band. Even 5 Mc/s instead of 3 Mc/s means a serious reduction of channels in a given allocated band of frequencies. In Bands I and III, for example, the U.K. system can use 13 channels while the European system, on 625 lines in the same range of frequencies, can use only 9 channels and each, of course, subject to this lack of horizontal information.

It is frequently argued that the 405-line standards are 20 years old and were the first in the world and are therefore somewhat out of date. Certainly other countries that have followed have progressively standardized on more and more lines.

However, this does not, *ipso facto*, mean that a 405-line system cannot produce all that is required for home entertainment. The quality of pictures we receive is not limited by the standards§ but by the price the public can afford or is prepared to pay.

At a price, it is very debatable whether 625-line C.C.I.R. European standards can give any better pictures than 405-line U.K. standards, despite the increased channel bandwidth and, even without price limitations, doubts still exist.

It is probable that reducing the lines from 625 to 525 within the same 5-Mc/s video bandwidth would improve rather than degrade the picture owing to the closer approach to reasonably balanced resolution, but even then the horizontal information factor would be less than we now have on 405 lines.

If we express the system goodness factors on a basis proposed by Hallows‖ but related to actual observed resolution capability (i.e. vertical resolution is, say, 0.8 of number of lines¶) we get the following figures:

Europe 625 lines (5 Mc/s): goodness factor 0.8.
U.S.A. 525 lines (4 Mc/s): goodness factor 0.78.
U.K. 405 lines (3 Mc/s): goodness factor 1.14.

There are additional hazards due to multipath reception as the number of lines and bandwidth is increased, and these hazards will be more pronounced as we move into the u.h.f. bands.

For a bandwidth of 3 Mc/s the time of duration of one picture element is approximately 0.14 μsec. The reception of signals by alternative paths of different lengths will cause an error in the time of arrival between the two signals. The speed of travel is about 186,000 miles per second, i.e. approximately 327 yards per μsec. Thus a secondary signal received at high level by reflection from a local re-radiator giving a path difference of 46 yards will produce two received pictures displaced by 0.14 μsec, i.e. halving the definition. As bandwidth is increased to permit more lines this effect is more pronounced; for example, for 5 Mc/s video signals the corresponding time for a picture element is 0.1 μsec, which is the time delay of a second signal arriving with a path length difference of 33 yards. As the path length difference is reduced the strength of the secondary signal for a given re-radiator will increase and cause a corresponding increase in the visibility of the ghost image. Thus for the European standards there is more chance of ghost images of sufficient strength causing a loss of resolution than for U.K. standards.

The question of more lines would probably not be raised if we made the lines invisible by spot wobble or by shaping the focused spot. If we did this, and removed line visibility as a point of argument, the questions of resolution in vertical and horizontal directions and the optimum relation between these properties would form a more realistic basis for discussion.

When we come to colour television the same arguments apply, but there is a further factor which offsets any advantage that might be claimed for more lines. With shadow-mask colour c.r. tubes the line structure is, for all practical purposes, invisible and if colour television using these tubes sets the fashion for "no lines" television then, once again, arguments based purely on lines and line visibility will be pointless.

Economic factors must surely be predominant in deciding standards. In a classic paper on the British television service** Sir Noel Ashbridge sums up the bandwidth and cost problem as follows.

"For all the main operations in television, from production in the studio right through to the receiver in the hands of the viewer, cost must constantly be kept in mind. The television standards adopted in the United Kingdom require only a 3-Mc/s signal bandwidth to produce a satisfactory picture. This restrained bandwidth keeps down technical complications and so reduces cost. It has enabled an economical signal transmission system to be developed and has made possible the design of high-power vision transmitters of relatively high efficiency. More important still, it has enabled the price of the simple domestic receiver to be kept down to a figure which permits wide sales. All parts of the transmission and reception chain would become more technically complex and more expensive with a higher-definition system. Any attempt to transmit a higher-definition signal over a system excessively restricted in bandwidth at any one link of the chain, whether such restriction is in the transmitter, the cable system, the receiver or elsewhere, can result in a received picture considerably inferior to that obtained from a 405-line signal handled throughout by properly designed 405-line equipment (Kirke 1948).

"It follows that a significant improvement in definition could be achieved only by incurring considerable increase in all-round costs. Thus the decision to maintain the 405-line system seems warranted by overall financial considerations as well as by the necessity for economizing in transmission channels."

§ "Editorial Comment," *Wireless World*, Oct. 1948. "Choice of Television Standards," *Wireless World*, July 1950, page 249, second col. "Comparison of Standards."

‖ "Television "Goodness Factor,"" R. W. Hallows, *Wireless World*, March 1949, page 87.

¶ "Principles of Television Engineering," Fink. Chapter II, Sec. 7, page 33, line 23.

** "The British Television Service." Sir Noel Ashbridge. Proceedings of Joint Engineering Conference, 1951, Part II, page 491.

Components Exhibition

REVIEW OF TRENDS AT THIS YEAR'S R.E.C.M.F. SHOW

The "private" exhibition held in London by the Radio and Electronic Component Manufacturers' Federation from 10th to 12th April is reviewed in these pages. In addition to describing in detail some of the new components and accessories shown, we give in each category a list of exhibitors and their main products. Test and measuring equipment, and also valves, will be in a later issue.

RESISTORS

AN interesting development this year is a range of high-precision resistance elements for use in volume controls where reliability is essential and both resistance and linearity tolerances have to be held to closer limits than usual. These are made by Plessey and the resistance element is actually an integral part of the body of the control. This is a high grade phenolic moulding which is extremely hard and has a glass-smooth surface. The resistive part of this element is a carbon composition track and the "binder" consists of the same material as the main moulding. Resistive element and body are moulded in one operation, with contacts moulded in where required. A centre ring for the "take-off" of the wiper contact can be moulded in also. The actual resistance track is about 15 mils thick and almost any resistance grading can be provided. Elements of this kind were shown in single track, twin track, segmental and strip form. The extreme hardness of the element's surface ensures a very long life and exceptional stability.

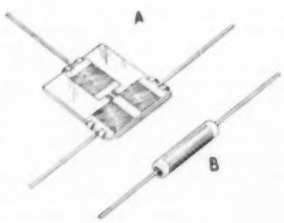
A new development in the metallized glass resistors made by Painton is to deposit a microscopically thin film of precious metal on to a glass fibre little thicker than a hair and then wind this metallized fibre, like wire, on a ceramic former. Very high resistance values are obtained in a small volume. The resistance range is comparable to that of high-stability carbon types, for example, but the permissible wattage is higher. A 1-watt glass-fibre resistor is about a quarter the size of an equivalent carbon type and about the same as that of a 1½-W wire-wound type. The resistor is protected by a coating of Araldite.

Section of Plessey high-precision resistive element showing track and moulded-in contacts.

Shown also by Painton were some resistive T pads constructed on the "Metlohm" principle of a precious metal film on a glass plate zig-zag scribed to produce a long resistance track. By having the three elements on a single plate, and produced by the same operation, stability and temperature coefficient are the same for all three.

There were numerous minor improvements to the existing ranges of all makes of resistors, but these were mainly of a constructional kind to make the resistors more adaptable to printed circuit applications.

Manufacturers: A.B. Metal Products, British Electric Res., Colvern, Dubilier, Egen, Electronic Comp., Electrothermal, Erg, Erie, Labgear, Morganite, N.S.F., Painton, Plessey, Salford, Walter Instruments, Welwyn, Zenith, W.B.



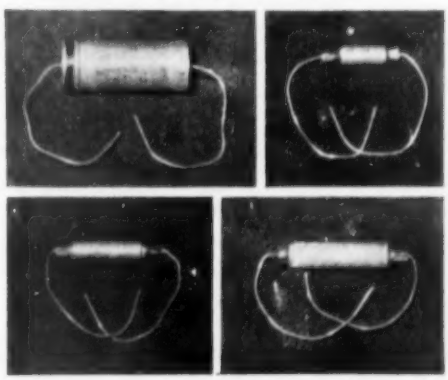
(A) Painton "Metlohm" T-pad metallized-glass resistance network and (B) new metallized glass-fibre resistor.

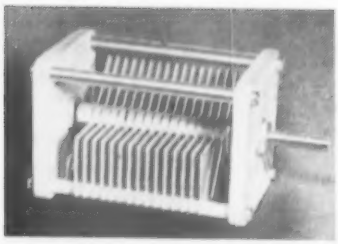
CAPACITORS

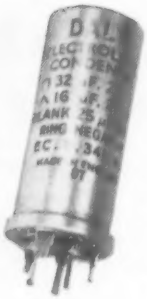
A DEVELOPMENT of more than usual interest is the introduction by Erie of a capacitor having voltage-sensitive characteristics. It provides a controlled change in capacitance with applied d.c. voltages and would appear to have useful applications in f.m. receivers and a.f.c. circuits generally. The dielectric is a thin plate of piezo-electric material with metallized surfaces and while present models have capacitances of the order of

T.C.C. printed circuit capacitators, showing a 50-μF Picapack, 32 + 32 + 16 μF, 350 V electrolytic and CP19ON 0.27 μF, 350 V moulded-case type.

Dubilier new capacitators including "Terecap" (largest) and three miniature electrolytics.







Eddystone Type 839 transmitting capacitor of 390 pF.

Right: Daly 32 + 16 μF, 270 V with 25 μF, 25 V electrolytic capacitors in a case only 1in in diameter for printed circuits.

75 to 100 pF larger values should eventually be obtainable.

In general the changes in design of capacitors are of a superficial kind and concerned mainly with making existing types more adaptable for use in printed circuits. While many of the current ceramic and tubular types are small enough for this purpose their usefulness has been extended either by repositioning the connecting wires or by fitting wires more suitable for the dip-soldering technique of printed circuit assembly.

One example is the T.C.C. CPI9ON, a 0.27-μF 350-V tubular housed in a $\frac{1}{4}$in diameter moulded plastic case $1\frac{7}{8}$in long with *both* wires brought out through a hard resinous wax seal at one end. Hunt had some new ceramics in disc and tubular form with connections positioned to suit printed circuit assembly and, in addition, a low-leakage range of polystyrene film capacitors.

Dubilier showed a new range called "Terecaps" which employs a Terylene film dielectric. In size they fall midway between metallized paper and separate paper and foil types and their principal characteristic of interest is that they can be used without derating up to 125 deg C. They are fully tropicalized, being hermetically sealed in metal cases.

Electrolytic capacitors are in general somewhat smaller this year for a given capacitance and in order to cater for printed circuit requirements there is an increase in the number of multiple-capacitor types modified for this purpose. The principal modification is in the positioning and shape of the fixing lugs and contacts. All these are located at one end of the capacitor. Whilst it is customary to restrict the multiple types to either high- or low-voltage capacitors, Daly have a range of mixed voltage types, one, for example, being 32 + 16 μF at 275 V working with 25 μF at 25 V working; these are in cases only 1in in diameter and $2\frac{1}{2}$in high.

On all the new models of printed-circuit metal-cased electrolytic capacitors the fixing lugs and base connections have an agreed shape and spacing and this generally conforms to the American standard for this type of capacitor.

Variable capacitors have not undergone much change, but some new models were seen. One of these was an Eddystone (Stratton) transmitting type which is assembled on $2\frac{1}{2}$-in square ceramic end-plates with all the metal parts heavily silver plated. It has a maximum capacitance of 390 pF and one of its applications is in π-type networks for matching random-length aerials to the output valve.

Manufacturers: Cyldon, Daly, Dubilier, Erie, Hunt, J.B., L.E.M., Mullard, Plessey, Stability Radio, Static Cond., Stratton, Suflex, T.C.C., T.M.C., Wego, Wingrove and Rovers, W.B., Walter Instr.

COILS AND TRANSFORMERS

AS one might expect, there were no major changes in iron-cored chokes and transformers, although a good deal of stress was laid upon the C-core types. There was, too, perhaps more than ever before, great emphasis upon hermetic sealing and, for the smaller varieties, encapsulation.

As extremes in miniaturization, the Fortiphone transformers for transistor circuits are noteworthy, since the smallest types are only slightly larger than the average transistor.

For r.f. circuits, tuning coils and i.f. transformers were shown by many firms and have changed but little. Among new components a discriminator transformer for an f.m. ratio detector is interesting in being designed for 38 Mc/s. It was shown by Cyldon and can be used with either thermionic or crystal diodes. The bandwidth is 820 kc/s; it is intended for use in television receivers which provide Band II reception.

Mullard showed a range of wideband matching transformers wound on Ferroxcube E cores and also adjustable Ferroxcube pot cores, which can be supplied wound. These are for high-Q inductors and, as an example, Q values up to 350 can be obtained in the inductance range of 10-300 mH.

Manufacturers: Bulgin, Cyldon, Eddystone, English Electric, Ferranti, Fortiphone, Haddon, Lion, Mullard, Parmeko, Partridge, Plessey, Rola, Weymouth, Whiteley, Wireless Telephone, Woden.

TELEVISION COMPONENTS

PARTS which are special to television comprise, in the main, scanning and focusing components, but it is also convenient to include tuners among them, although they are more in the nature of sub-assemblies than components.

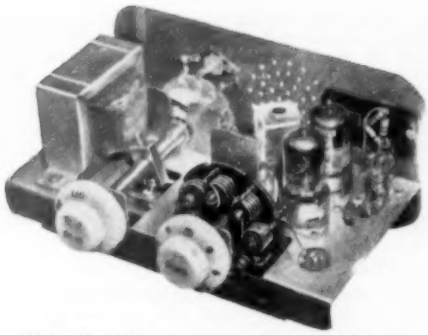
The increasing use of 21-in tubes of 90° deflection angle has resulted in more deflector-coil assemblies for such tubes being produced. Some models were shown last year and the general form of the design on view this year was much the same, although detail differences exist. The castellated iron circuit, so common in assemblies for 70° tubes, is not used in the 90° types. Instead, a plain ferrite ring is employed; this is wound with four coils for the frame deflection so that these coils are of the so-called toroidal type. The line coils, however, are of the bent-up end kind and the front ends are flared to fit around the conical part of the c.r. tube. With the increasing scan power, insulation is becoming much more important and, in the Plessey assembly, it is provided by a polyethylene moulding; it is claimed that ionization does not start below 4.5 kV and, as the normal peak voltage is around 3.5 kV, there is a reasonable factor of safety.

A tendency to fit small permanent magnets to deflector-coil assemblies was noticed. They are in the form of rods, mounted vertically, one on each side of an assembly and on the outside. Their purpose is to correct for pincushion distortion of the raster.

Line-scan transformers are becoming almost conventional in their general form although detail changes are constantly being made. The core is invariably ferrite, or some material with similar electrical properties, with one window, the winding usually being on one limb only. Resistance wire is commonly used for the e.h.t. overwind to reduce ringing effects and supplies of 16 kV, and even 18 kV, are obtainable.

Focus components and ion traps remain substantially unchanged in form. The favourite arrangement is a pair of cross-magnetized rings acting in opposition and with adjustable spacing as a focus control. James Neill, however, retain the form which they introduced two years ago of three equi-spaced radial bar magnets within a pressed steel case. The case is in two parts movable with respect to each other, to give a variable air gap as a control of the focus field.

Turning now to tuners, there is little or no change in circuitry and the cascode r.f. stage with a triode-pentode frequency changer is normal. The turret tuner is common but the incremental-inductance type with switch selection is also widely used. The changes are in



Wolsey Band III convertor with turret coil selector.

details. Improvements in the layout of components have produced small increases of gain and a lower noise level and, perhaps more important, better uniformity between different samples. Oscillator frequency stability is improving, too.

The Band III convertor is even less of a component than the tuner and very few were shown at the exhibition. Wolsey had one, however, in the form of a self-contained unit with a well-finished case, which is unusual in having a Band III turret for the oscillator coils. One switch gives a changeover between bands and the turret provides selection among the Band III channels.

Manufacturers*: Aerialite (C); Cyldon (T); Long & Hambly (M); James Neill (F); N.S.F. (T); Plessey (D, F, T, Tr.); Thermo-Plastics (M); Whiteley (D, Tr.); Wolsey (C).

***Abbreviations:** C, convertors; D, deflector coils; F, focus units and ion trap magnets; M, masks; T, tuners; Tr, transformers.

SUB-ASSEMBLIES

A VERY simple and flexible system for the construction and manufacture of sub-assemblies was demonstrated this year by Erie. Standard resistors and capacitors are selected and laid out on a tagboard, then wired into the required circuit and immersed in a sealing compound, leaving projecting pins for the connections. Anything between 2 and about 100 components can be assembled in this way, according to the customer's specification, and because there is no tooling involved it is quite easy to make changes to the circuits in the middle of a production run. The design is said to be suitable for automatic assembly methods in the manufacture of electronic equipment.

The general technique of "potting" sub-assemblies in blocks of resin was represented by many examples on the stand of Lion Electronic Developments. A particular unit of some topical interest constructed in this way was a voltage multiplier for supplying a 5-kV polarizing voltage for an electrostatic loudspeaker. Designed by Westinghouse, it contains 5 miniature tubular rectifiers and 6 small ceramic capacitors, and is intended to work from the 700-V a.c. provided by the 350V-0-350V winding of a mains transformer.

Sub-assemblies are very widely used in electronic computers, especially those designed on the "packaging" principle, and at the show this application was represented by a new kind of plug-in unit made by McMurdo. The valve and associated components are built into an inverted-U length of rod which forms both the main support and the handle for plugging in the unit.

A great many sub-assemblies are nowadays mounted on printed circuits, and a representative selection of such circuit plates was to be seen on the T.C.C. stand. This firm was also showing special printed circuits having the conductors flush with the surface of the base material; printed circuits on flexible bases (treated papers, resins, polythene, etc.), and examples with conductors brought out to one edge for insertion into multi-way sockets or connectors.

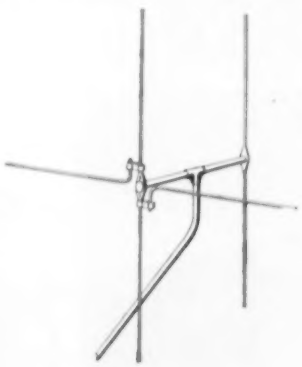
There were, of course, quite a number of coil packs and filter units to be seen. Of particular interest on the Dubilier stand was a u.h.f. suppression filter, covering 200-1300 Mc/s, for insertion in the power supply leads of transmitting equipment. It is a double-T network, using two disc capacitors and a straight-through inductor wire with a ferrite sleeve, and is built into a small cylinder sealed with resin. The attenuation of the unit is in the region of 60db at 1300 Mc/s.

Manufacturers*: Aerialite (IS); Antiference (IS); Bakelite (PC); Belling and Lee (F, IS); B.I.C. (DN); Bulgin (IS); Cyldon (TD); Dubilier (DN, F); Ediswan (TD); Electro Methods (PC); Erie (IS, CA, PC); Ferranti (DN, F); Hunt (IS, PC); Labgear (BE, F, IS); Lion (DN, CA, F); McMurdo (CA); Morganite (IS); Mullard (F, TD); N.S.F. (TD); Plessey (F, IS, PC, TD); Static Condenser (IS); S.T.C. (BE, IS); Stratton (TD); T.C.C. (DN, IS, PC); Thermo Plastics (F); T.M.C. (IS); Walter (PC); Wego (DN); Westinghouse (RA); Weymouth (DN, F, TD); Wingrove and Rogers (TD).

***Abbreviations:** BE, battery eliminators; CA, component assemblies; DN, delay networks; F, filters; IS, interference suppressors; PC, printed circuits; RA, rectifier assemblies; TD, tuning devices.

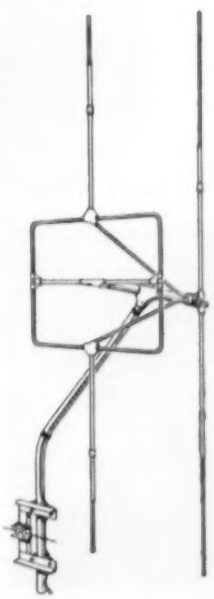
AERIALS

THE television aerials made by J-Beam have always been a little unorthodox in design; for example, the end-connected feeder to the Band I dipole adopted a few years ago; the skeleton-slot beams of last year and now the "Hornbeams" shown this year. The "Hornbeam" is a combined Band I/Band III aerial and, as the illustration shows, consists of a square combined



Antiference Addex FM adaptor rods fitted to Band I H aerial

Dubilier u.h.f. suppression filter.



New "Hornbeam II" Band I/Band III aerial made by J-Beam Aerials.

with a "V" with two vertical rods joined to the top and bottom sides of the square. Apart from these two rods the sides of the square and the arms of the "V" are all approximately a half-wavelength long at Band III frequencies.

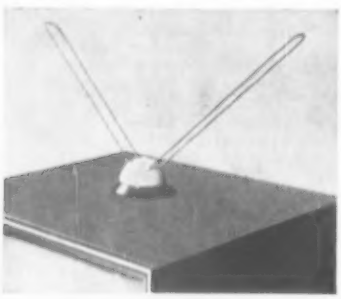
The skeleton square plus "V" section form the Band III system, and this is said to exhibit the unusually broad bandwidth of 170 to 230 Mc/s without the voltage standing-wave ratio exceeding about 1.5 to 1. The Band I section, consisting of the vertical rods and the two vertical sides of the square in parallel, is less broad so the vertical rods are adjustable for tuning to the required Band I channel. A 75-ohm coaxial cable is connected to the apex of the "V" and no cross-over network is required. It can be used either vertically, as shown, or horizontally.

Apart from this novel aerial the main changes appear to be towards consolidating the various designs introduced last year. Ranges have been extended and mechanical features improved where necessary. As an example the add-on elements made by Antiference have now been extended to include an Addex/FM set for use on vertical television aerials and where the receiver has provision for f.m. reception.

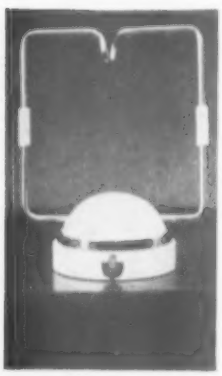
More attention has been given to indoor Band III aerials, as it appears that within 5 to 10 miles of an I.T.A. station this kind of aerial can quite often be used successfully. Wolsey have a small square aerial for standing on top of the receiver which they call the "HI-Q"; it consists of a full-wave dipole bent into a square with a small loading coil in the top side. Provision is made to plug in the feeder from a Band I aerial, and there is a cross-over network in the base.

A folded dipole bent in the shape of a "V" and mounted on a base, also with a cross-over network incorporated for a Band I aerial connection, was shown by Aerialite. It is known as the "Viking." Aerialite had also a new "Multiway" indoor aerial, mainly, but not exclusively, for loft mounting, which provides 18 different combinations of Band I, Band III or Band I/Band III aerials according to the way the rods are inserted in the universal-type centre insulator. Another indoor aerial giving choice of several types, such as Vs, Ts, Ls, etc., was shown by Antiference. This firm has introduced also a simple coaxial cable plug in which the cable is fixed by crimping the sleeve of the plug on to the bared copper braid of the cable. The centre conductor has to be soldered in.

Manufacturers: Aerialite, Antiference, Belling-Lee, B.I. Callender's, Henleys, J-Beam, Labgear, Permanoid, Telcon, Telerection, Wolsey.



Aerialite "Viking" Band III indoor folded dipole.



Left: Wolsey "HI-Q" Band III indoor aerial.

SWITCHES

THERE were no really outstanding developments in the design of switches to be seen this year, but just a series of small improvements. In rotary switches some attention is being given to the better fixing of the stator contacts, which often become loose with continued operation. Walter Instruments, for example, were showing a switch in which the fixed contacts were locked in position by a staple clip. This gives improved security in operation and also prevents the contacts from being loosened by overheating during soldering. A similar improvement was to be seen in a new Plessey rotary switch. Here the contacts are held by a flat wedge type of rivet which not only gives better lateral support but enables them to be mounted on the surface of the wafer instead of in cut-away sections. This makes for a stronger wafer and incidentally allows the conventional rotor to be repaced by a more rigid assembly.

Two other new rotary switches were shown by A.B. Metal Products. The first was a new size, half-way between the ordinary "OAK" type and the miniature "OAK," and was notable for a simpler and cheaper index spring mechanism. The second was intended for switching very small currents in electronic instruments and was equipped with PTFE wafers having an insulation resistance of not less than 10^{14} ohms. This firm also had a wide range of piano-action switches including several miniature types.

Micro-switches with a great variety of actuating mechanisms—plungers, levers, rollers, leaf springs—and actuating pressures were to be seen on both the Pye and Bulgin stands. Normally these switches do not lock into the closed state but Bulgin now have a number of models which do. This firm has also devised a system for ganging micro-switches.

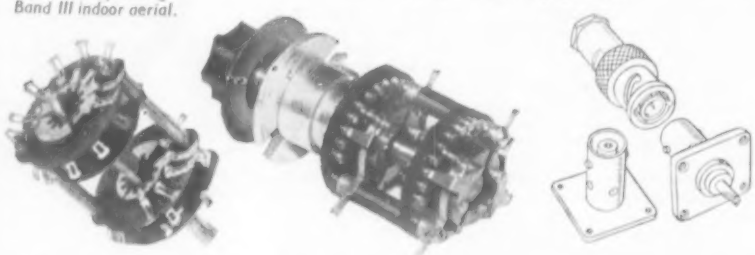
Manufacturers:* A.B. Metal Products (L, P, PA, R, S); B.E.R.C.O. (R); Bulgin (L, M, P, R); Diamond H (L, R); Electronic Components (P, R); N.S.F. (L, P, R, S); Painton (L, P, R); Plessey (L, P, PA, R, S); Pullin (R); Pye (M); T.M.C. (L, P); Walter (L, P, R, S); Whiteley (P, R, S); Wright and Weaire (R).

***Abbreviations:** L, lever or toggle; M, micro-switch; P, push-button; PA, piano action; R, rotary; S, slide.

CHASSIS FITTINGS

IN this section probably the most topical trend in design was special fittings for printed circuits. Valveholders

(*Continued on page 179*)



Above: Plessey rotary switch of improved construction. Centre: Electronic Components 4-pole 10-way instrument stud switch. Right: Besson and Robinson coaxial connectors with bayonet locking.

E.M.I. INSTITUTES EXPANSION

Extension of Training Schemes for Electronic application

SCHOLARSHIPS FOR TWO COURSES

In step with wide expansion of Electric & Musical Industries Ltd. into the development of electronic and automation equipments for industry, E.M.I. Institutes the training organisation in the Group has considerably extended its plans for the future.

The 4-year Scholarship scheme introduced several years back to encourage suitable candidates to take up careers in Electronics has proved most successful and a similar scheme is now introduced for the first time for the 3-year Telecommunications Course.

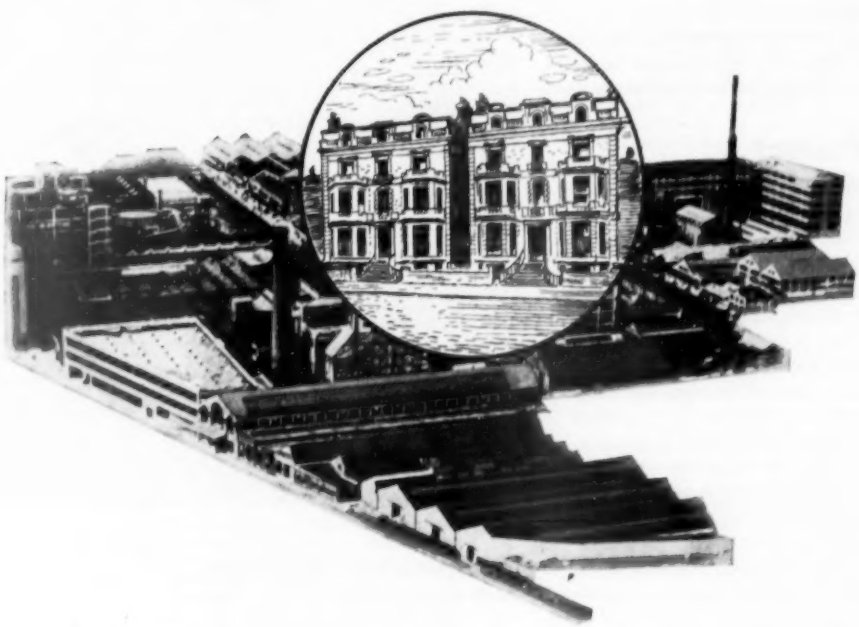
In addition to the courses listed below, E.M.I. Institutes are arranging special courses for the E.M.I. Group and the customers of the Group. Present activities and future plans include courses for Digital and Analogue Computers, Process Control and Automation.

Full-time courses open to the general public are as follows:—

4-YEAR COURSE: Electronic Engineering—intended for good Science sixth-formers who are capable of training into future team leaders in scientific applications. Final qualifications are B.Sc. and City and Guilds' Full Technological Certificate in Telecommunications Engineering. This course is recognised by the Institution of Electrical Engineers. At least 18 E.M.I. Scholarships are offered for the 1956 course which commences on October 2nd.

3-YEAR COURSE: Telecommunications—Entrance standard G.C.E. Ordinary level or equivalent. This course trains Assistant Development Engineers to City and Guilds' Full Technological Certificate level. Opportunities for practical attachments to E.M.I. Laboratories and Workshops are provided. Details of special Scholarship scheme available for next course, commencing September 11th.

1-YEAR COURSE: Full-time day course in the Principles and Practice of Radio and Television. Mainly designed for the training of Radio and Television Servicing Engineers. Next course, commencing May 22nd, is already fully booked. Enrolments for following course, commencing September 11th, now being accepted.

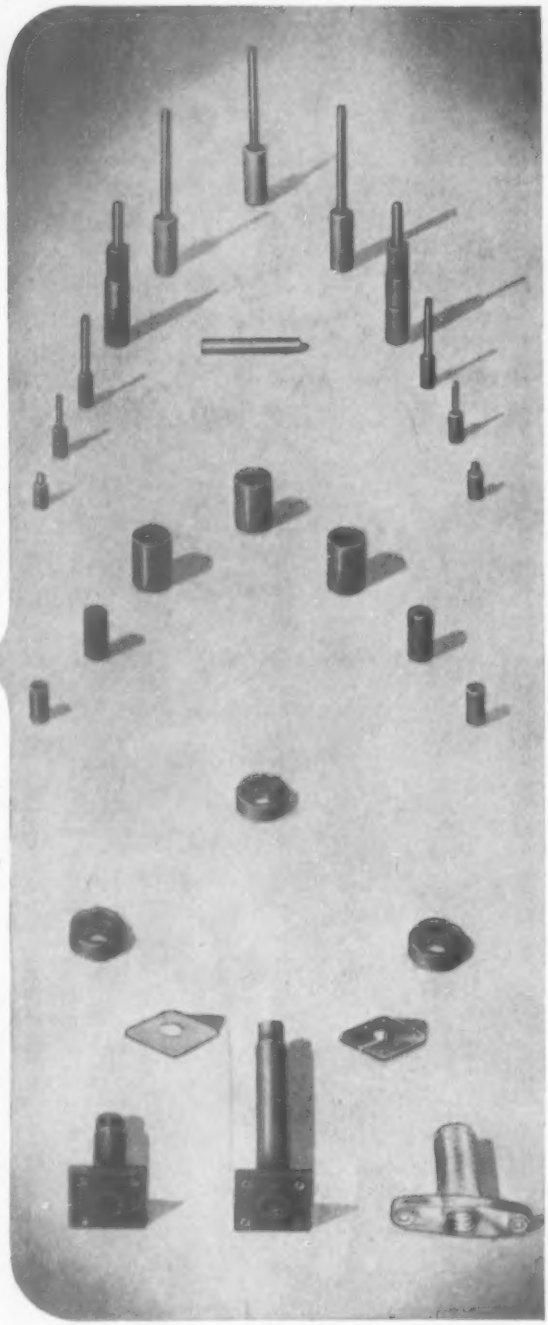


E.M.I. INSTITUTES LTD. 10 PEMBRIDGE SQUARE, LONDON, W.2

Caslite

Iron Dust Cores

by **Plessey**



Bigger Standard Range . . .

Under the registered name CASLITE, The Plessey Company presents a range of superior iron dust cores of the types in constant demand by the radio industry. New manufacturing techniques developed at the Towcester factory have resulted not only in the establishment of a better product within the various material gradings but also in more economic production. In consequence, prices are keenly competitive.

Where cores outside the standard range are required, the Company is always willing to advise on design and to produce iron dust cores to suit special needs.

Better Product . . .

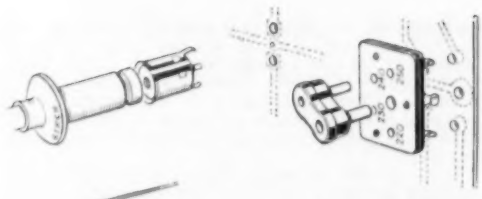
Due almost entirely to their own continuity of effort to improve the performance of iron dust cores, The Plessey Company now hold an unchallenged position in the breadth and quality of their standard range of cores, both for use at normal I.F. and broadcast frequencies and again for the more recent exploitation of the V.H.F. region and television. In the latter context, the Company is able to announce the introduction of several materials possessing greatly improved qualities for use in these fields. These are the Grade 22 and Grade 23 powders, mechanically suitable for use in conventional constructions and available at economic prices.

Manufacturers are invited to write for Plessey Publication No. 650/2 which contains comprehensive details of these products.

'Caslite' Iron Dust Cores are produced by

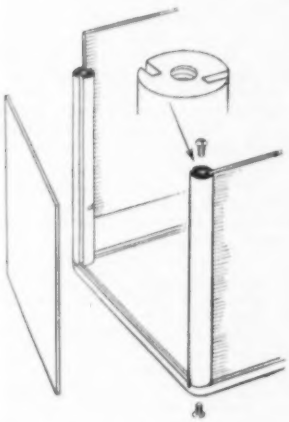
THE CHEMICAL & METALLURGICAL DIVISION OF PLESSEY • WOOD BURCOTE WAY • TOWCESTER • NORTHANTS

PC2a

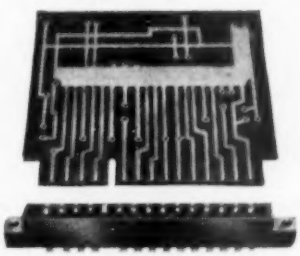


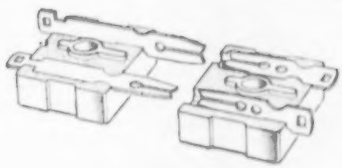
Above: Carr Fastener coaxial socket and mains-voltage selector for printed circuits.

Right: Unusual Ediswan Clix holder for alphabetical indicator tube (16 contacts).



Above: Widney-Dorlec miniature cabinet system. Right: Electro Methods strip connector for printed circuits.





Basic units of the N.S.F. "Varicon" unitized connector system. These can be stacked as required and secured by a central fixing screw through the holes.

for this application are quite common now and also strip connectors for linking the circuits with conventional wiring; usually one side of the connector forms a long socket into which an edge of the printed-circuit plate is pushed. Two of the latest fittings in the printed-circuit category, shown by Carr Fastener, were a coaxial-cable socket and a mains-voltage selector (see sketch at top of page).

Amongst the more conventional fittings, multi-way connectors of miniature construction were shown by several firms, while McMurdo had plugs and sockets moulded in nylon which were notable for their very low insertion force.

A particularly interesting form of construction for connectors could be seen on the N.S.F. stand. It is used in a "unitized" system in which plugs and sockets of any size can be built up from four basic parts, two contacts and two mouldings, and is best explained by the sketch. The contacts are unusual in that they fit into each other with their planes at right angles. The arrangement gives a very effective union between the surfaces and also prevents the plugs from being inserted the wrong way round.

Belling and Lee "Unitors" now have a modified socket giving reduced contact resistance and lower insertion force, and a lever-actuated extractor is a feature of the new design of retainer. This firm was also showing single nylon-insulated square-faced sockets in various colours. Amongst coaxial connectors, Besson and Robinson had some new miniature types in which the two halves are held together by a bayonet locking arrangement (see sketch on page 178).

Valve-circuit supports or turret assemblies (for mounting a valve and a small group of components) were shown in various forms by several firms this year, one using ceramic insulation. Usually they are cylindrical in construction, but Carr Fastener had a new type using straight tagstrips across the central support. Another device built around a valveholder was a mains-voltage selector (McMurdo). The valveholder formed a socket, while a plug sliding on a central spindle could be rotated and inserted at different angular positions for the different voltages.

Cabinets can hardly be described as chassis fittings, but we must find a corner to mention a new type of "prefabricated" cabinet construction brought out by Widney-Dorlec. As can be seen from the sketch, it consists of a top plate (not shown) and a bottom plate fixed together at the corners by four aluminium rods, into which slots are cut (and also into the plates) for locating the aluminium or steel side panels. The method is only suitable for making up small cabinets and is intended principally for housing miniaturized equipments.

Manufacturers: Aerialite, Antiference, Belling and Lee, Bulgin, Carr Fastener, Colvern, Creators, Ediswan Clix, Egen, Electronic Components, Electrothermal, Hassett and Harper, Hellerman, Igranic, Imhof, Long and Hambly, McMurdo, Micanite, Painton, Plessey, Power Controls, Ross Courtney, Salter, Simmonds, Spear, Standard Insulator, Stocko, Stratton, Thermo Plastics, Tucker Eyelet, Whiteley, Widney-Dorlec, Wimbledon, Wingrove and Rogers, Wireless Telephone Company.

MATERIALS

ALTHOUGH the field of electrical insulants is nowadays dominated by the synthetic plastics it is interesting to observe that mica—one of the oldest known insulants—still plays an important rôle. By itself it is widely used as a condenser dielectric and for electrode bridges in valve manufacture; in combination with bonding media it finds application in a variety of proprietary sheet, tube and rod materials. A new injection moulding material "Mycalon" has been introduced by Mycalex and T.I.M., Ltd., in which the bonding medium is glass. It has been evolved in conjunction with the Ministry of Supply to meet conditions of high humidity and its initial surface resistivity of 10^{12} ohms per square is recovered within one and a half hours after six humidity

cycles. The power factor is 0.0011 and the permittivity 9.6 at 1 Mc/s.

Fibre glass is much to the fore these days as a reinforcing material for silicone elastomers and other plastics. A coil former was shown by Langley London in silicone-bonded glass fibre in which the thread for locating a spaced-turn single layer winding was formed in the moulding operation. A fabric woven from glass fibre and regularly interspersed with metallic threads forms the basis of a resin-bonded radar reflector which was shown by Thermo-Plastics, Ltd.

Nylon is now firmly established with other plastics used in the production of insulating sleeving and is sought after for any applications requiring enhanced abrasion resistance.

In addition to the thermo-setting adhesive insulating tapes with paper, acetate and glass fibre backing, the Minnesota Mining and Manufacturing Company were showing an extruded PTFE tape designed for bonding by heat.

The substitution of a chlorine atom in polytetrafluoroethylene (PTFE) produces polymonochlorotrifluoroethylene (PCTFE), which exhibits comparable electrical, thermal and mechanical properties and is easier to mould. The Edison Swan Electric Company showed a wide variety of applications for these materials in radio components and as coverings for rollers and the jaws of heat-sealing machines where freedom from sticking is a fundamental requirement.

Cellular polythene, which came to the fore in Band III television aerial cables, is now being applied by B.I.C.C. to a wider range of r.f. cables with improved performance. The use of "Irraydol"—a brand of irradiated polythene—is something of a novelty among the r.f. cables made by Wandleside Cable Works. Although the power factor is slightly lowered, the thermal stability is increased up to 200°C and there is greater resistance to attack by mineral oils.

Among new instrument wires a solder-coated wire for dip-soldered assemblies by Henley's, and a bunched textile-covered wire with self-fluxing enamelled strands by Fine Wires were noted.

Refinements in melting and heat treatment have resulted in magnetic materials (both soft and hard) with enhanced performance characteristics. The Telegraph Construction and Maintenance Company are now producing "Super Mumetal" with initial and maximum permeabilities of 50,000 and 200,000 compared with 25,000 and 90,000 for the standard alloy. "Special Radiometal" is now available with initial and maximum permeabilities of 4,500 (2,000) and 45,000 (25,000). Another Telcon achievement is the production of Mumetal 0.0007-in foil in widths up to 6in for use in radar pulse transformers and other high-frequency applications.

In the permanent magnet industry a decision has been taken by member firms of the Permanent Magnet Association to proceed with the commercial production of "semi-columnar" magnets in a limited range of sizes and proportions. While not showing the spectacular performance of the experimental "Columax" these "S.C." alloys show a marked improvement over "Alcomax" at an economic price. Much ingenuity is evident in the design of composite magnets with a variety of methods of bonding the soft and hard components. James Neill showed the versatility of the resin-bonding technique and Swift Levick gave examples of a dowelled intercast method of producing composite sintered and cast iron/Alcomax instrument magnets.

Manufacturers:* Aerialite (C, IS, W); Aero Research (IM); Anglo-American Vulcanised Fibre (CF, IM); Associated Technical Manufacturers (B, C, IM, IS, W); Bakelite (IM); Geo. Bray (CE); B.I. Callenders (C, CO, IS, S, W); British Moulded Plastics (IM); Bullers (CE); Clarke (CF, IM, IS); Connollys (C, IM, W); Cosmocord (CF); Creators (IS); Darwins (M); De La Rue (IM, IS), Duratube and Wire (B, C, CO, IS, W); English Electric (L); Enthoven (S); Fine Wires (W); Guest, Keen and Nettlefolds (B); Hellerman (IM, IS); Henley's (C, CO, IM, W); Insulating Components and Materials, Ltd. (IM); Langley London (IM); Linton and Hurst (L); Lion Electronic Developments (IM); London Electric Wire and Smitting (W); Long and Hambley (IM, IS, RP); Magnetic and Electrical Alloys (L, M); Marrison and Catherall (M, L); Mica and Micanite Supplies (IM); Micanite and Insulators (CF, IM, IS); Minnesota Mining (IM); Mullard (DC, M); Multicore (S); Murex (RM, M); Mycalex (IM); James Neill (M); Permanoid (C, IM, IS, W); Plessey (CE, DC, M); Reliance Wire (C, CO, IS, W); Salford (DC, M); Sankey (L); Geo. L. Scott (L); F. D. Sims (C, CO, W); Standard Insulator (RP); S.T.C. (M); Steatite (CE); Suflex (B, CO, IM, IS, W); Swift Levick (M); H. D. Symons (IM, IS); Technical Ceramics (PC); Telcon (C, DC, IM, L, M, RM, W); Telcon Magnetic (L); Telephone Manufacturing Co. (DC); Thermo Plastics (IM); Tufnol (IM); United Insulator (CF, CE, IM); Vactite Wire (RM, W); Wandleside Cable Works (C, CO, W); Whiteley Electrical (CF, M).

***Abbreviations:** B, braiding; BO, bolts; C, cables; CE, ceramics; CF, coil formers, bobbins; CO, cords; DC, dust cores, ferrites; IM, insulating materials; IS, insulating sleeving; L, core laminations and strip; M, magnets and magnetic alloys; PC, piezoelectric ceramics; RM, refractory metals; RP, rubber products; S, solder; W, bare or covered wires.

WORKED ALL ZONES

C. G. ALLEN, who is the first British amateur (G8IG) to win an international award for having made two-way 'phone contact with amateurs in all the forty zones of the world. This award, which comes from the United States, has been won only once before—by an amateur in Kenya—since it was first introduced some twenty years ago. "Bert" Allen is a director and sales manager of McMichael Radio, Ltd., which he joined in 1923, having previously been a ship's operator.

British Colour Television

A GLANCE AT THE PRESENT SITUATION

THIS month a glimpse of the present state of British colour television development was given, in the form of demonstrations, to a study group of the International Radio Consultative Committee on a visit to this country. If these demonstrations helped to clarify the international minds of the C.C.I.R. people, they did very little to sort out the domestic situation as we see it in Britain at the moment. One feels the need for a general stocktaking of the situation.

First of all, then, what of the C.C.I.R. demonstrations themselves? These were arranged by the Post Office and included visits to B.B.C. establishments, to the G.P.O. Research Station and to E.M.I. Research Laboratories. Only one event, however, was thrown open to the Press. This was a demonstration in London by B.R.E.M.A. of various experimental colour receivers built by their member firms and working on N.T.S.C.-type transmissions radiated by the B.B.C. from Alexandra Palace.

The transmitting equipment at Alexandra Palace has already been described in *Wireless World** and also the essentials of the N.T.S.C. type of system†. There were 14 experimental colour receivers in operation and seven ordinary monochrome sets for showing the effect of compatible transmissions on existing black-and-white receivers. One of the colour receivers, described elsewhere in this issue, appeared to be in a more advanced state of development than the other equipments but could not be considered as a prototype for mass-produced domestic sets. This and several other of the receivers were built around the 21-inch RCA shadow-mask tri-colour c.r. tube. There were also sets using the earlier 15-inch RCA colour tube and some equipments with rear projection display systems.

In the view of *Wireless World* the pictures on the 21-inch direct-viewing receivers were markedly superior to the others—particularly in colour rendering, brightness and definition. Indeed they were the best colour television pictures we have ever seen. That is not to say, however, that they were perfect. There was quite a wide divergence of colour rendering between different receivers, and in some cases the divergences appeared on the same set. On one screen, for example, the flesh colour of a performer's hands was completely different from that of his face, although neither could be said to be unnatural. On another set, the hue of an actress's lemon-yellow dress fluctuated from greenish-yellow to almost orange in a matter of a few seconds.

Some of the colour receivers were designed for operation on wide-band colour information and some for narrow-band colour information, but one could see no difference between the respective pictures, except occasionally in areas of very small colour detail.

The monochrome receivers, incidentally, gave a very good picture on the compatible colour transmissions and one had to examine the screens very closely in order to see the sub-carrier dot pattern. What was really remarkable, however, was the demonstration of "reverse compatibility"—that is, the colour receivers giving black-and-white pictures from ordinary monochrome transmissions (which the B.B.C put out after the colour transmissions). It was difficult to believe that the black-and-white pictures were actually being produced by red, green and blue c.r.t. phosphors until one took a magnifying glass to the tube screens and saw the individual phosphor dots fluorescing in their respective colours.

This, then, was the British N.T.S.C. system—and one more experimental transmission to add to the many others that the B.B.C. have been doing in conjunction with B.R.E.M.A. over the past six months or so. But what of the other systems that are supposed to be under consideration for a possible service in Britain? The three most important ones all work on the principle of transmitting the chrominance information on sub-carriers *outside* of the normal vision band (unlike the N.T.S.C. system). The first two of these three systems can be considered as being (perhaps) compatible with our present television service in Band I, because although the colour sub-carriers of the stations would overlap the vision bands of stations in adjacent channels, it is thought that the interference between them would not be too serious. (One of these "overlapping" systems uses two colour sub-carriers while the other has a single quadrature-modulated sub-carrier of the N.T.S.C. type.)

The third system under consideration is a wide-band one using two colour sub-carriers outside the normal vision band but *not* overlapping the adjacent channel. In other words, it requires a wider channel than is at present available in Band I and so would not be compatible with our existing service. It could, however, be used to provide a compatible service in Bands IV or V.

The fact remains, however, that none of these alternatives to the N.T.S.C. system has actually been investigated in a really practical way, and at the moment it seems they are only regarded as an insurance against the possible failure of the N.T.S.C. system. One very simple reason for this is, apparently, that the only suitable transmitting equipment available for tests is at present completely tied up with N.T.S.C.-type transmissions! Whether any such tests will be carried out eventually on the alternative systems remains to be seen, but at the moment, at any rate, the N.T.S.C. system appears to be the firm favourite.

Cost of Receivers

The choice of a colour system is influenced partly by whether we need compatibility or not,‡ and this in turn depends on a variety of political, social and economic factors. The question of bandwidth and conservation of ether space come into it also, and now there is controversy in progress on the matter of standards—whether we should go to 625 lines for colour or stick to 405 (see page 173). Perhaps one of the most important considerations in the choice of a system, however, is whether it will allow receivers to be mass-produced for the domestic market at reasonable prices.

At least one firm in Britain has worked out in detail the cost of manufacturing receivers for operating on the N.T.S.C. system, and it seems that the price cannot be brought much below £300 for a set. This is much too high to make colour television a practical proposition. It should be said, however, that receivers for the alternative systems would probably cost almost as much, for in all of them a simultaneous colour display system has to be used, and this is what accounts for the biggest proportion of the total cost. Receiver circuitry with some of the alternative systems is likely to cost less than with the N.T.S.C. system because of the simpler demodulation of the chrominance signals, but it is still necessary to have extra equipment of some kind for colour, whatever the system. On this question of receiver cost, then, it seems there is not much to choose between the systems at present under consideration. What is needed is a completely new system which requires simple circuitry and an inexpensive colour display apparatus—something as simple and inexpensive as the old frame-sequential system—but that is unlikely to be found. It is more probable that we shall have to adopt one of the four systems already described and put our trust in future development to reduce the cost of the colour display apparatus and the complications of the circuitry.

* "Colour Television Tests," *Wireless World*, December, 1955.
† "Transmitting Colour Information," *Wireless World*, August, 1955.
‡ "Must We Have Compatibility?" *Wireless World*, December, 1954.

MODIFICATIONS TO THE

Sensitive Three-Valve T.R.F. Receiver

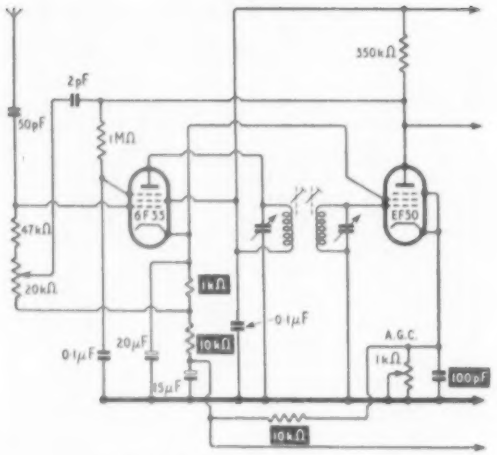
CIRCUIT CHANGES FOR OPTIMUM PERFORMANCE WITH 6F33 VALVE

By H. E. STYLES, B.Sc.

IN notes on the above receiver, published in the January (1956) issue of *Wireless World*, it was stated that a 6F33 might be employed as an alternative to an EF50 with a diode connected between suppressor and cathode. It may be desirable to point out that owing to differences between the operating characteristics of 6F33 and EF50 valves a direct substitution is not practicable and an appropriately modified circuit for the r.f. and detector stages is given here. Comparison with Fig. 5 on page 618 of the December, 1955, issue of *Wireless World* will show what modifications are required.

These changes ensure that the 6F33 operates with a cathode potential of about 100 V and a cathode current of about 5 mA. Maximum screen dissipation is thereby limited to 0.8 W specified by the valve maker.

It was found that owing to the somewhat lower gain obtainable from a 6F33, reaction becomes inadequate unless a 100 pF capacitor is shunted across the cathode resistor. Introduction of this capacitor reduces negative feed-back of r.f. potentials to the grid of the detector valve. As a consequence, the latter valve produces a greater amplitude of r.f. at its anode and reaction is thereby enhanced sufficiently to outweigh the reduced gain of the r.f. stage. It is probable also that detection efficiency may be improved by addition of this capacitor.



The modified circuit discussed in the text.

The 6F33, which can also be obtained under the designation CV239, possesses a much shorter suppressor grid base than the EF50. This is distinctly advantageous in that it enables adequate gain control to be obtained on a strong signal without depressing the anode potential of the detector valve to any marked extent. Detector overloading is thereby completely obviated and a longer aerial can be employed without risk of distortion on local stations.

CLUB NEWS

A.W.R.A.R.S.—Membership of the recently formed Army Wireless Reserve Amateur Radio Society is open to any serving or past member of the Army Wireless Reserve Squadron or any other Royal Signals unit. Details of the Society's activities, which are stated to be entirely non-military, are obtainable from the chairman, A. D. Taylor (G8PG), 37 Pickerill Road, Greasby, Wirral, Cheshire, or the secretary, J. A. Bladon (G3FDU), "Madresfield," Jack Lane, Davenham, Northwich, Cheshire.

Barnsley.—At the May 11th meeting of the Barnsley and District Amateur Radio Club, J. Ward (G4JJ), chairman of the club, will speak on transistor developments. Meetings are held on alternate Fridays at 7.0 at the King George Hotel, Peel Street, Barnsley. Sec.: P. Carbutt (G2AFV), 33 Woodstock Road, Barnsley.

Birmingham.—C. H. Banks, of C.J.R. Electrical and Electronic Development Limited, will speak on "Industrial Control" at the May 11th meeting of the Slade Radio Society. A fortnight later N. B. Simmonds will deal with rectifier circuits. Meetings are held at 7.45 at the Church House, High Street, Erdington. Sec.: C. N. Smart, 110 Woolmore Road, Erdington, Birmingham 23.

Bromley.—At the monthly meeting of the Bromley Radio Club (North West Kent Amateur Radio Society) on May 4th, there will be a discussion on the National Field-Day. Meetings are held at 8.0 at Shortlands Hotel, Station Road, Shortlands, Kent.

Bury.—The Bury Radio Society has recently been reorganized and meetings are now being held on the second Tuesday of each month at 8.0 at the George Hotel, Kay Gardens. Information on the club activities is obtainable from John E. Hodgkins (G3EJF), 24 Beryl Avenue, Tottington, near Bury, Lancs.

Chelmsford.—The next meeting of the Chelmsford group of the British Amateur Television Club will be held at 7.30 on May 10th in Marconi College, Arbour Lane, Chelmsford. F. H. Townsend, vice president of the club, will speak on "Recent developments in camera tubes." Sec.: D. W. Wheele (G3AKJ), 56 Burlington Gardens, Chadwell Heath, Essex.

Cheltenham.—"Multi-channel telephony" is the title of the talk to be given by E. G. Smith (G.P.O.) on May 2nd to members of the Spen Valley and District Radio and Television Society. On the 16th G. F. Craven will deal with the interpretation of valve characteristics. A joint meeting of the Spen Valley, Leeds and Bradford societies will be held on May 30th at the Leeds G.P.O; subject, "Transatlantic Cable". Sec.: N. Pride, 100 Raikes Lane, Birstall, near Leeds.

Crystal Palace.—The Crystal Palace and District Radio Club has been formed to widen the scope of the activities of the Norwood and District R.S.G.B. Group. Meetings are held on the third Saturday of each month at 8 in Windermere House, Westow Street, Crystal Palace. Sec.: G. M. C. Stone (G3FZL), 10 Liphook Crescent, Forest Hill, London, S.E.23.

Edgware.—The headquarters of the Edgware and District Radio Society (G3ASR) are now at Canons Park Community Centre, Merrion Avenue, Stanmore, where meetings are held each Wednesday at 8. Sec.: E. W. Taylor (G3GRT), 99 Portland Crescent, Stanmore, Middx.

Portsmouth.—Meetings of the Portsmouth and District Radio Society, which is affiliated to the Royal Marine Signal Club, are held each Tuesday evening at the British Legion Club, Queens Crescent, Southsea. Sec.: L. B. Rooms (G8BU), 51 Locksway Road, Milton, Portsmouth.

Experimental Colour Receiver

THE COLOUR KILLER AND THE TRI-COLOUR C.R.T. CIRCUITS

BY H. A. FAIRHURST*

(Continued from page 118, March issue)

IN a colour receiver it is not essential, but very desirable, that the chrominance amplifier should have automatic gain control, for although the receiver is itself controlled, this can do nothing about selective fading which may alter the relative amplitudes of the video and colour information. Therefore some means of obtaining a suitable control voltage must be found.

The colour synchronizing burst immediately suggests itself as the source of such a voltage, for it consists of a fixed amplitude and duration of just the frequency round which the colour information is centred. Very conveniently, too, it has already been gated out of the signal and is ready for use. The colour burst is rectified by a diode in a conventional manner and the resulting negative voltage applied to the grid of the first chrominance amplifier (Fig. 7). A delay diode delays the application of this voltage by a small amount.

The colour killer must now be described (left-hand side of Fig. 7). This is not an essential part of a colour receiver but it is a desirable adjunct, for in its absence a monochrome picture received on the colour receiver could be crawling with the coloured noise called "parc." This effect is due to the inability of the colour demodulators to distinguish between chrominance sub-carrier plus sidebands and luminance information which contains similar frequencies. Such frequencies in the luminance band beat with the reference oscillator and produce coloured streaks of light, or, in the case of the higher frequency blocks of Test Card C, bright rainbow hued bands. The colour killer is therefore a circuit which "kills" the chrominance amplifier in the absence of a colour sub-carrier, i.e., on a monochrome picture, and as a colour sub-carrier is or can be arranged to be always accompanied by the colour burst, the killer can be made to depend on the presence or absence of the burst.

It would seem at first glance, therefore, that the colour killer must be possessed of magical properties, unless it is to consist of a separate amplifier chain and rectifier in parallel with the chrominance amplifier, provided solely to kill the chrominance amplifier in the absence of the burst. Otherwise the colour killer must be able to "know" when the burst is there, and this possibly when the amplifier is already cut off because a monochrome picture has been transmitted just previously. Fortunately circuits exist which perform this task and recourse to the expensive alternative is not necessary.

The colour killer circuit adopted in this receiver (Fig. 7) makes use of the fact that it is possible to observe whether the burst is present or not once a line, notwithstanding the fact that the chrominance amplifier is cut off during the rest of the line period. A suitably timed positive-going pulse is applied to the grid of the a.g.c.-controlled and colour-killed chrominance amplifier which brings it into a state of conduction. If there is a burst present, this is amplified normally and is rectified to produce the a.g.c. voltage. As well as controlling the gain of the first chrominance valve, this negative voltage also controls the colour killer, which has positive-going gating pulses on its anode and negative-going pulses on its grid derived from the line timebase.

Colour Saturation Control

In the presence of a burst, and hence the presence of the negative a.g.c. voltage, the colour killer is cut off and the negative-going pulses on its grid have no effect on the anode circuit. However, in the anode circuit are positive-going pulses whose amplitude is adjustable by the potentiometer, and these pulses drive the chrominance amplifier into grid current, thus providing a bias in addition to that of the a.g.c. voltage. As the amount of this additional bias is controllable by the potentiometer, this becomes a very convenient "saturation" control.

Taking the case where no burst is present, the a.g.c. voltage becomes zero, thereby causing the colour killer to conduct. The negative pulses on its grid now produce large positive pulses on the anode which in their turn cut off the first chrominance amplifier by virtue of the grid current that flows. It will be seen, however, that the chrominance amplifier is always switched on during the time interval when the burst occurs; therefore the killer circuit is always able to recognize whether the burst is there or not. A potentiometer allows the setting of the killer bias to the correct working point.

A thing worth noting with this arrangement of switching the amplifier to full gain during the burst

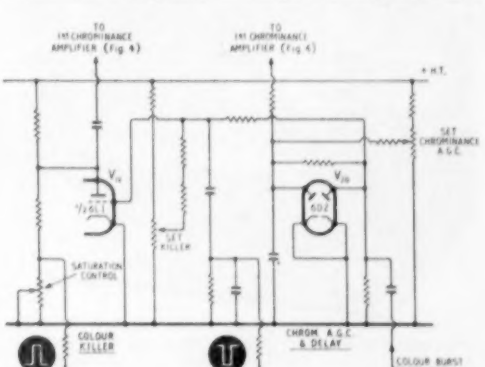


Fig. 7. The colour killer and chrominance a.g.c. stages.

* Murphy Radio. This article is based on a lecture given by the author to the Television Society. The receiver, among others, was recently demonstrated operating from "live" B.B.C. test transmissions on the occasion of the visit of C.C.I.R. Study Group XI to Britain.

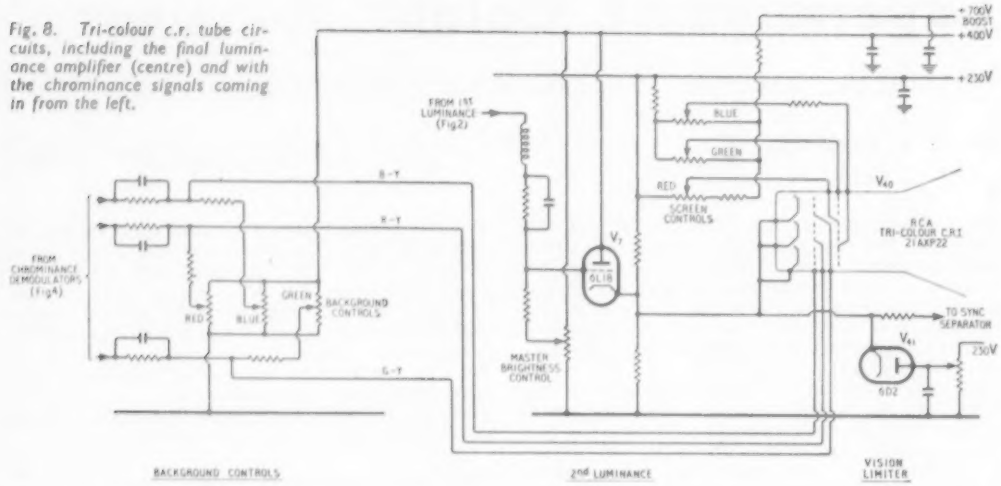
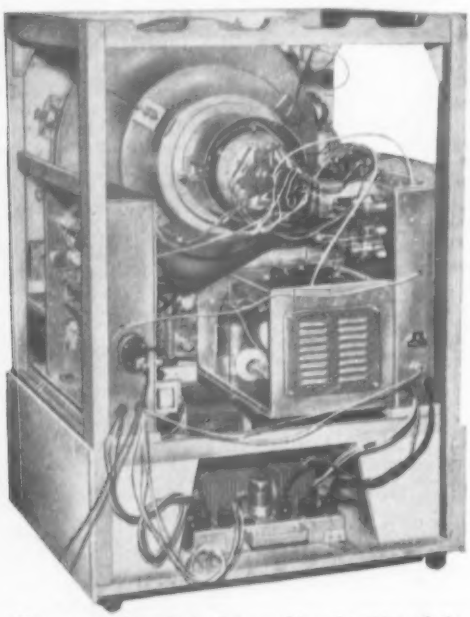


Fig. 8. Tri-colour c.r. tube circuits, including the final luminance amplifier (centre) and with the chrominance signals coming in from the left.

period is that perfect a.g.c. control can be achieved with only one controlled valve, an impossibility with normal circuits.

Before dealing with the timebases and ancillary equipment it will serve a useful purpose to enumerate the requirements of the three-gun shadow-mask c.r. tube. First and foremost there must be means for adjusting the individual electron guns so that their cut-off points fall at the right voltage with, at the same time, the right length of grid base. Without this possibility the tube would give the correct colour rendering at one brightness only. Secondly, the three electron beams must be made to strike the shadow mask at substantially the same spot over the whole of the picture area. Thirdly, the scanning generators must be capable of delivering sufficient power to scan the tube—at the elevated e.h.t. which is required to give sufficient brightness and a good enough focus.



The accessibility obtained by making the sides of the cabinet detachable. The timebase and e.h.t. chassis on the right has its screen removed. The dynamic convergence yoke can be seen on the end of the tube.

Right at the outset of the design, in order to save time, it was decided to use RCA components as far as possible in the scanning and e.h.t. circuits, but it was soon found that the line-scan transformer which was suitable for 525 lines was not equally suitable for the British 405 lines. The work on the display side therefore divided itself into two parts: the design of a line-scan circuit which would scan the tube and produce a stabilized 25-kV e.h.t. supply capable of delivering 1 mA, and the donkey work of adapting the American tube control circuits to suit the particular receiver.

Taking these last-mentioned circuits first and referring to the circuit diagram (Fig. 8) it will be seen that there are three "background" controls which enable the R, G and B guns to be set to the correct level of brightness. These are set in conjunction with the three screen controls which are in effect potentiometers between the boost line and + h.t. These latter provide an adjustment of the grid bases of the individual guns, the cathodes, grids and screens acting as triodes. Once these six controls are set, the picture brightness can be altered by the master brightness control, which is in the cathode-follower circuit.

Included in the circuits which had to be adapted to the present receiver are the vertical and horizontal shifts. If it is not obvious from the outset that a tube containing three separate electron guns requires something more than a shuffle plate if the registration is not to go amiss when shifting the picture, it very soon becomes self evident that such simple devices are of no use.

In fact, the method adopted is that of passing d.c.

(*Continued on p.* 185)

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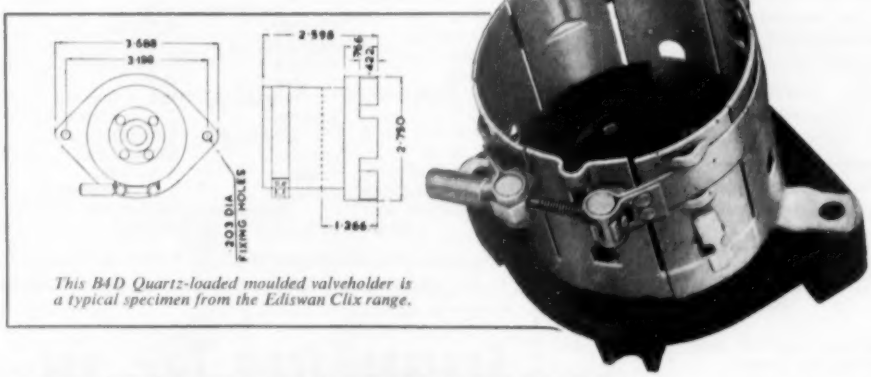

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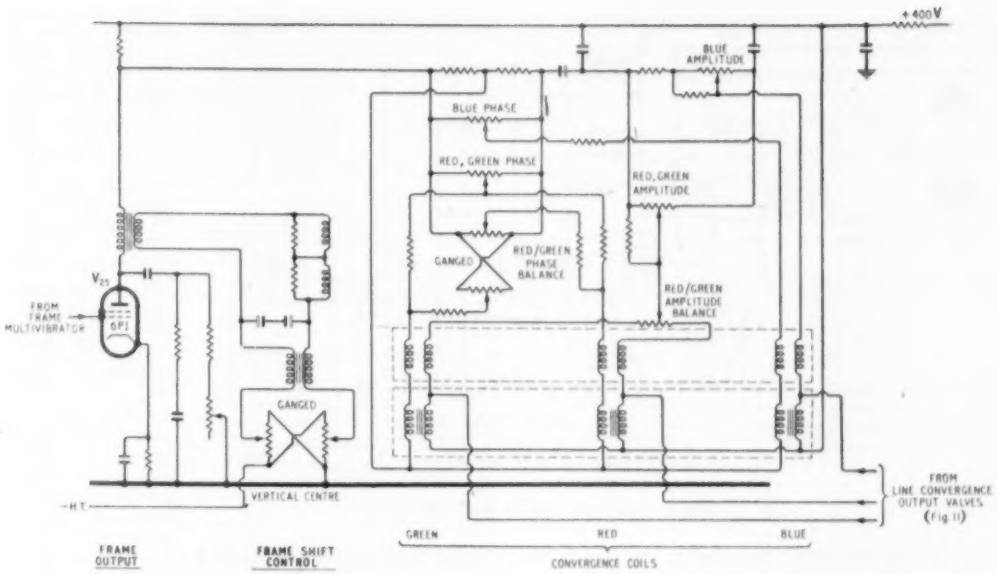


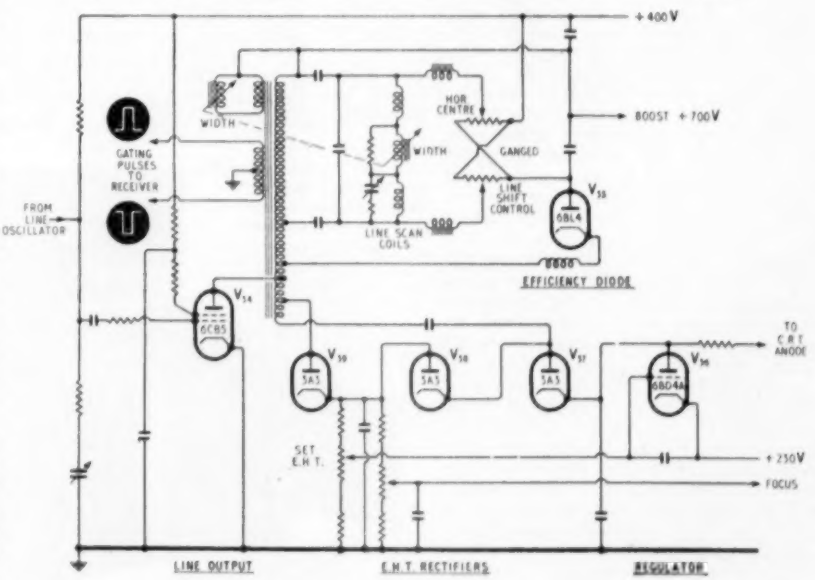
Fig. 9. Frame convergence circuits, including the frame timebase output valve (left) and the convergence coils.

through the scanning coils themselves, and as the scanning currents must not be short-circuited through the power supply, suitable decoupling chokes must be provided. As it is desirable to be able to shift the picture both ways, dual cross-connected potentiometers are provided. The frame shift control (Fig. 9) is isolated from the scanning circuit by a suitable transformer and high-value electrolytic capacitors while the line shift (Fig. 10) is isolated by chokes and the d.c. prevented from getting into the line transformer by isolating capacitors.

Before dealing with the time bases themselves, and taking the last of the display requirements peculiar to the shadow-mask tube, we come to the convergence circuits. These are circuits for energizing an additional scanning assembly known as the convergence yoke. Into this assembly are fed currents of suitable amplitude and phase for adjusting the beam position of all three guns so that they coincide all over the face of the tube. The convergence yoke differs from the ordinary scanning coils in that it has three coil assemblies on it, each one of which has its greatest effect on one gun only. Into each individual coil assembly can be fed currents derived from the line and frame timebases.

The form of the currents required for convergence in a vertical direction is largely parabolic and can be

Fig. 10. Line timebase output, showing line shift control circuit and e.h.t rectifiers.



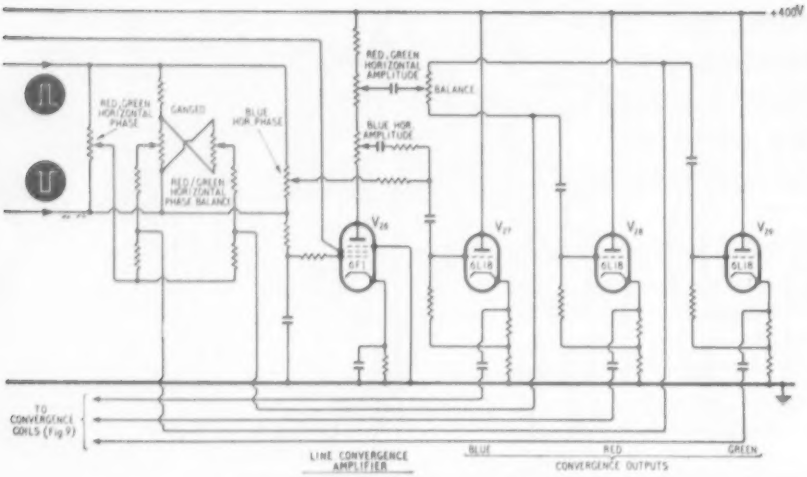


Fig. 11. Line convergence amplifier and output valves.

derived from the frame timebase by suitable R and C circuits (Fig. 9). There naturally have to be three outputs, each controllable both in amplitude and phase. In the case of the horizontal convergence, an attempt was made to carry out this operation with static circuits on the lines suggested in information supplied by RCA, but without a great deal of success. It may be that a reasonable compromise can be reached at 15 kc/s, whereas it cannot at 10 kc/s, or it may be that we had set our standards rather higher, but in the end it was decided to use valves for the job, and the circuit shown in Fig. 11 was the result.

In this circuit, integrated pulses from the line timebase fed on to the grid of the amplifier valve appear in amplified form on its anode. The correct proportions of this amplified sawtooth are fed on to the grids of the three convergence output valves in conjunction with a pulse from the line timebase in such a manner that the resulting waveform drives the correct current through the convergence coils. The output valves are merely cathode followers to obtain the low impedance source that is necessary.

Controls are provided to adjust both the amplitude and phase of the pulse and sawtooth, and in practice these are adjusted until the correct current waveform is produced. The correct current is of course that which gives the best convergence of the three beams over the whole screen, and as the line and frame convergence controls are by no means independent of each other, it will be appreciated that the correct setting-up of the convergence is no mean feat.

Turning now to the timebases themselves, the frame timebase (Fig. 9 shows the output valve) can be dismissed in very few words, its sole departure from normality being the amount of current required to scan the tube. As, however, the sensitivity of the frame coils is relatively high, a normal 5-watt output valve is quite suitable.

The line timebase, however, is somewhat specialized in that it has to provide an e.h.t. supply of 1 mA at 25 kV in addition to scanning the tube. The circuit of the timebase itself is conventional, but it uses an American type valve, a 6CB5, in the output stage (Fig. 10) as being the only one available at the inception of the design capable of doing the job. The economy diode is also an American type — a 6BL4. The line timebase has to supply the necessary gating pulses for the receiver and these are provided by a special winding.

The line timebase is frequency controlled by a conventional a.f.c. loop, and here of course there was a wide choice of circuits available, although somewhat naturally the one chosen was a circuit in common use in our laboratories. The discriminator diode in this circuit has to be fed with equal amounts of positive- and negative-going sync pulses, and these are provided by a phase splitter valve which is half a double triode. The sync separator itself is conventional and needs no further mention. The other half of the phase-splitter double triode is used to remove the line clutter from the differentiated frame sync pulses before passing them on to the frame timebase.

As has been stated, the e.h.t. requirements for the shadow-mask c.r. tube are 25 kV at 1 mA (most of which goes into the shadow-mask itself) and this must be stabilized to ensure good registration at all picture brightnesses. A voltage doubler circuit has been used with a third rectifier as a one-way device to prevent the pulse on the anode of V37 from

The timebase and e.h.t chassis, showing the complete screening achieved.

appearing on the cathode of V39. Shunted across the output of the supply is a stabilizing triode, a 6BD4A, which has been specially developed for the purpose. Its grid is connected to a tap low down on a potentiometer between the cathode of V39 and earth, and this tap can be varied to control the e.h.t. In action the total current drawn by the c.r. tube and the stabilizer valve is more or less constant, as any change in the loading of the c.r. tube alters the grid voltage of the stabilizer in such a sense that the change of current through it compensates almost exactly.

The shadow mask c.r. tube, being electrostatically focused, needs a source of focusing voltage, and this is provided by a shunt across the "undoubled" e.h.t. rail.

There remains only the h.t. power supply, whose only out-of-the-ordinary feature is the number of milliamps required. The actual equipment contains two large metal half-wave rectifiers in a doubling arrangement, providing a 230-V rail and a 400-V rail, with a total consumption of 600 milliamperes. The 400-V rail is used to feed the timebases, the luminance cathode follower and the chrominance demodulators, while the 230-V rail feeds the receiver section, the screen grid of the frame output valve, and the screen grid of the horizontal convergence amplifier. In series with the common h.t. return is a small resistance which provides a negative source of 10 volts for the frame shift.

A receiver using 40 valves and a 21-in cathode-ray tube is naturally no small object, and when it is considered that the RCA shadow-mask c.r. tube has a metal cone at a potential of 25 kV it will be realized that something special has to be done to ensure the safety of the personnel operating it.

In view, also, of the uses to which the receiver was to be put, it was thought advisable that it should go through an ordinary living-room door, so considerable effort was put into the mechanical design, much more than would be necessary for the normal laboratory experimental receiver. Accessibility, too, was considered most important, and all the setting-up controls have been brought out to the front. The sides of the cabinet are detachable, allowing free access to the undersides of the timebase and receiver chassis, which are mounted vertically on each side of the tube. The power supply chassis is out of the way on the base of the cabinet.

In operation with the cabinet open there are no exposed live parts other than ordinary h.t. and boost rails, and the boost feeds only the c.r. tube screen controls. The timebase is completely screened and the metal cone of the tube is protected by a polythene shroud, so no particular precautions against shock need be taken other than those normally adopted by engineers in the laboratory. With the cabinet closed, of course, there are no live exposed parts whatsoever, the metal escutcheon round the protective glass being bonded to earth. The protective glass is ¼in thick and is in itself a sufficient protection against X-rays.

The setting-up and operation of the receiver is not a subject that can be dismissed in a few words, as there are not only the convergence, screen and background adjustments to be made, but also the colour purity to check to ensure that the red, green and blue guns hit centrally the red, green and blue phosphor dots respectively all over the screen. This colour purity is controlled by movable permanent magnets on the neck of the tube. On a yoke round the periphery of the face-plate are adjustable magnets to compensate for stray fields. When it is considered that all these adjustments are more or less interdependent, it will be realized that the setting-up of a shadow-mask c.r. tube is more a matter for practical experience rather than a wordy description of the process. The matter will be dismissed, therefore, with the assurance that although the process may take nearly all day the first time it is attempted, skill is rapidly attained until the whole sequence can be gone through in an hour or so. There is also the saving grace that once set the adjustments appear to stay put.

In conclusion the author would like to convey a few messages of thanks to various people. To begin with, and speaking for all television workers, we in Britain certainly owe a debt of gratitude to the members of the N.T.S.C. committee in America, first for developing their extremely elegant system of colour television and secondly for being so forthcoming in the publication of results. Next, thanks are due to RCA for their assistance in supplying information and parts, without which the receiver would have been much longer in the designing, and to the B.B.C. for their immense help at all stages. Last, but not least, a "thank you" to the group of engineers without whose intense efforts the receiver would not have seen the light of day nor this article have been written.

ONE of the laboratories in the post-graduate School of Electronics established by Automatic Telephone and Electric Company and its associates, which include B.I. Callenders and Hivac. The School, which recently held its first open day, is situated within the company's main works at Liverpool and has at present accommodation for 30 students. There are two types of course provided—one lasting 3 months and the other a year. Prospective students are, in the main, selected from the company's staff and are paid whilst studying.

Distortion—Audible and Visible

Relationship between Amplitude/Frequency and Phase/Frequency Response

By "CATHODE RAY"

A LITTLE quiet entertainment has been afforded by perusal of successive issues of British Standards in which the approved names for various kinds of distortion are set forth. As the older *Wireless World* readers may remember (and the younger ones too, if they have read the volume I have been plugging with a shamelessness rivalling that of the B.B.C. in their interview programmes—"Second Thoughts on Radio Theory"), one of my hobbies is hurling bricks at the promoters of misleading or illogical technical terms. British Standard 204 of 1943 provided a particularly attractive group of targets. One of them was "non-linear distortion," for my rude remarks on which see p. 388 of the book just mentioned. The footnote on its next page records with satisfaction that in BS.2065 of 1954 "non-linearity distortion" was admitted as an alternative. Now, in BS.661 of 1955, "non-linearity distortion" has been promoted into first place and "non-linear distortion" banished altogether.

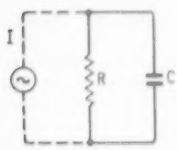


Fig. 1. The voltage set up across a resistance by a given signal current decreases with increasing frequency of current if there is a capacitance (intentional or otherwise) across it.

This little progression is satisfactory more as a sign that authorities may be open to reason than because of the objectionableness of the term in question, which is no worse than a little loose. A more outstanding target was "attenuation distortion," because it was not only not in general use but was no improvement on the term that *was* in general use—"frequency distortion," mentioned by BS.204 only to black-list it as "Deprecated." Now, although I myself have used "frequency distortion" I will readily admit that it is wrong. But at least it gives people a chance of guessing the correct meaning, whereas if "attenuation distortion" suggests any meaning at all it is unlikely to be the right one. Evidently the British Standards Institution began to think so too, for in BS.2065 they substituted the precise term "amplitude/frequency distortion," with "frequency distortion" as a permitted alternative. This was evidently too much for some of their advisors, for although in BS.661 "amplitude/frequency distortion" is retained as the recommended term we find "attenuation/frequency distortion" as an alternative and "frequency distortion" deprecated again. There is still some inconsistency, for whereas "phase distortion" is a permitted alternative for "phase frequency distortion," "amplitude distortion" is a result of non-linearity and is not at all the same thing as "amplitude/frequency distortion." It will be interesting to see what the next edition of BS.204 says!

The reason for this preliminary argument about terms is that I find myself rather stuck by my own fussiness, for this month's subject is to be a comparison between what (to give them their precise names) I must call "amplitude/frequency distortion" and "phase/frequency distortion," and these do seem a bit of a mouthful for repeated use. And, for the reason just explained, although one of them can be abbreviated to "phase distortion" the other must not be "amplitude distortion." So for the purposes of this article I am going to call the things "a/f.d." and "p/f.d."

The terms thus abbreviated are so precise that they hardly need explanation, but it may be as well just to make sure that we all know what we are talking about.

In such things as sound or vision communicating and reproducing equipment, there should be equal treatment of all the wanted frequencies. For instance, if one assumes that full reproduction of sound necessitates 20 to 20,000 c/s, then a graph of overall amplification or transmission against frequency should be perfectly flat between these limits. One would than be able to say that the a/f.d. was nil. If, however, the graph increasingly sloped downwards above, say, 3,000 c/s the a/f.d. would by "high-fidelity" standards be serious. So would a fall-off below 300 c/s.

Vector Diagrams Again

In general, a/f.d. is caused by inductance and capacitance, because (unlike resistance) their impedance varies directly or inversely with frequency. In an amplifier, for example, the useful frequency band is often limited at the top by capacitance causing a falling impedance in shunt with the signal path, and at the bottom by capacitance causing a rising impedance in series. It was these simple and common effects that we considered in connection with Nyquist negative-feedback diagrams.* You may, perhaps, remember how those diagrams showed very clearly that long before shunt capacitance is sufficient to cause an appreciable drop in amplification it has a very pronounced effect on *phase*.

Now, of course, this is not necessarily connected with feedback, and the reason it showed up in Nyquist diagrams is because basically they are vector diagrams. One of the merits of vector diagrams is that they show amplitude changes clearly and phase shifts even more clearly. It happens that the explanation in the December 1955 issue of how a simple Nyquist diagram is formed could be used all over again now for our comparison of a/f.d. and p/f.d. For the sake of any who don't remember, or can't refer to it, here is a summary.

At the upper frequencies the circuit in which a

*In the December 1955 and January and February 1956 issues.

signal voltage is set up is very often equivalent to that shown in Fig. 1, where a signal current I flows through a resistance and a capacitance in parallel. The resistance may be that of a coupling resistor in parallel with the resistance of the signal source (a valve, for instance). The capacitance may be due to a capacitor used to suppress frequencies beyond the wanted band, but quite often it is no more than the inevitable stray capacitance of the circuit. The signal voltage is equal to I multiplied by Z, the impedance of R and C in parallel, and for purposes of comparison I is assumed to be the same at all frequencies, so the amplitude/frequency characteristic in this case is really the same as a graph of Z against frequency.

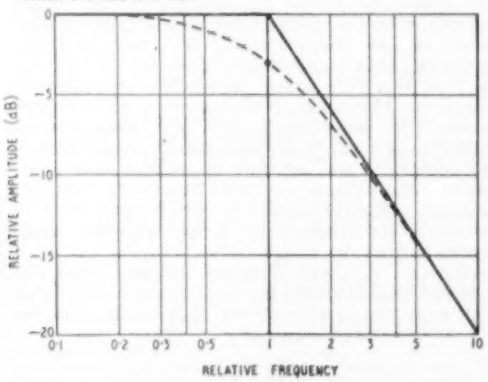
Not only does this particular Z decrease in magnitude with increasing frequency, but an increasing phase difference develops between the current I and the voltage. So there are three interrelated quantities—amplitude (or magnitude of Z, denoted by $|Z|$), phase difference (denoted by ϕ), and frequency (f). A single two-dimensional graph shows only two things at a time, but where sound reproduction is concerned phase difference can be left out of account, because nobody has succeeded in showing that it makes any audible difference—at least, in the sort of situation we are considering now; stereophony is a different matter. So the usual form of graph for the purpose is simply $|Z|$ (or its equivalent) against f.

For plotting this graph, $|Z|$ can be calculated for a number of frequencies from the formula

$$|Z| = \frac{R}{\sqrt{1 + (2\pi fCR)^2}}$$

and the ratio of $|Z|$ to R can be expressed either as a fraction or in decibels, as a measure of the a/f.d. But there is a much easier way. At very low frequencies $(2\pi fCR)^2$ is so small compared with 1 that it can be neglected and so $|Z|$ is practically equal to R alone, and the ratio of one to the other is practically 1, so this part of the graph is a horizontal line at 1 (or 0 dB). At very high frequencies, 1 is so small compared with $(2\pi fCR)^2$ that it can be neglected and so $|Z|$ is practically

Fig. 2. The decrease in voltage in Fig. 1 varies with frequency as shown by the dotted curve. The two straight lines, meeting at the frequency at which the shunting reactance is equal to the resistance, are a good approximation to the curve at frequencies well off that point, at which the loss is 3 dB.



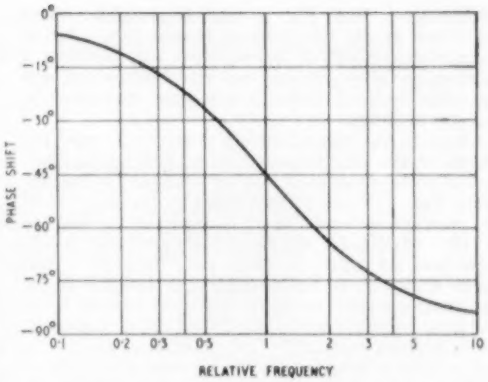


Fig. 3. Phase shift corresponding to amplitude loss shown in Fig. 2.

$1/2\pi fC$, which is the impedance of C alone. This is inversely proportional to frequency, so can be represented on the graph by a line that slopes off in such a way as to halve the amplitude for each doubling of the frequency. Halving amplitude is a drop of 6 dB and doubling frequency is a rise of one octave, so the slope of this line is commonly called 6 dB per octave. If a logarithmic frequency scale is used, to match the dB scale which of course is logarithmic, the sloping line is straight, as in Fig. 2. The frequency at which the two straight lines meet is the one at which the impedance of C is equal to R; that is, $1/2\pi fC = R$, so $f = 1/2\pi CR$. It is what we called the "turning frequency."

Rapid Plotting

At this particular frequency, neither 1 nor $(2\pi fCR)^2$ is negligible compared with the other; in fact they are equal. It is here, naturally, that the two-straight-line approximation is furthest from the truth; since $(2\pi fCR)^2 = 1$, $|Z|/R = 1/\sqrt{2} = 0.707$, which is −3 on a dB scale. This accurate point can be plotted on the graph, and it gives one a mark for drawing a smooth curve (dotted in Fig. 2) connecting up the two lines.

Note that just as we have "normalized" the amplitude scale by relating Z to R, so we have treated the frequency scale, relating all frequencies to the turning frequency. So the Fig. 2 graph holds good for all circuits that can be reduced to Fig. 1; to convert its relative frequency scale to actual frequencies for any particular values of C and R, multiply it by $1/2\pi CR$.

Precisely the same curve applies when the upper-frequency drop is caused by series inductance instead of shunt capacitance. Because the inductive impedance is $2\pi fL$ the turning frequency is $R/2\pi L$.

The same graph turned around left to right is correct for lower-frequency drop due to series C or shunt L, the turning frequencies being calculated in the same way.

It is generally agreed that until a/f.d. amounts to 3 dB it is hardly noticeable, so the effective frequency band of a piece of sound-reproducing equipment is usually reckoned between the upper and lower −3 dB points. If only "single-order"

arrangements like Fig. 1 are responsible, these points are at the two turning frequencies. But in a complete system, of course, there are generally a number of things causing top and bottom cut, and the effective band width is narrower than that for any one of them.

Although the accompanying phase shifts may not matter to the ear, they do matter if negative-feedback is to be used, so it may be necessary to supplement Fig. 2 by a phase/frequency graph. (Just as "amplitude" was to be understood as relative to the amplitude at middle frequencies where there was no a/f.d., so it is for "phase.") The phase angle, ϕ, is the angle whose tangent is the ratio of resistance to shunt reactance, or of series reactance to resistance; so for Fig. 1 $\tan \phi = 2\pi fCR$. At the turning frequency, $f = 1/2\pi CR$, so $\tan \phi = 1$, and a table of tangents shows ϕ to be 45°. Strictly speaking it is $-45°$, because the phase is lagging. Calculating a few more points to plot, we get Fig. 3.

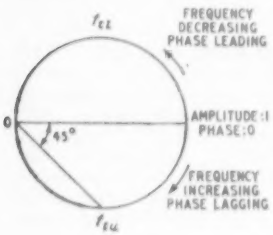


Fig. 4. The circle is the track of the tip of a vector hinged at O, representing signal voltage in a circuit where there is "single-order" cut-off at both high and low frequencies, as the frequency is varied. The vector Of_{tu} corresponds to the marked point at -3 dB in Fig. 2.

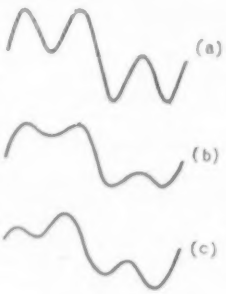


Fig. 5. Waveform (a) is made up of two sine waves of equal amplitude and 3:1 frequency ratio. When the amplification of the higher frequency is reduced relatively to the lower by 7 dB, (b) is the result. The accompanying phase shift further distorts the waveform to (c).

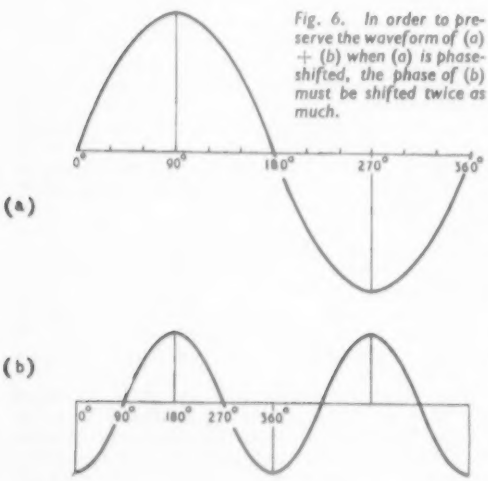


Fig. 6. In order to preserve the waveform of (a) + (b) when (a) is phase-shifted, the phase of (b) must be shifted twice as much.

It serves also for series inductance, but for low-frequency cut the graph must not only be turned left to right but the − become +.

These two graphs taken together show that phase starts noticeably sliding down before amplitude (so it is lucky our ears don't detect the phase shift), but for this particular comparison the vector form of graph is neater. Since we have so recently gone fully into this, I'll just show Fig. 4 as a reminder. The only difference between it and those we used in connection with feedback is that because it was negative feedback we were interested in they were upside down. But we still have the familiar circular shape. The "origin" is marked "O," and the horizontal diameter starting from it is the vector representing no distortion. Its length represents the amplitude, taken as 1 for comparison, and the fact that it points at 3 o'clock is the conventional way of showing that its phase angle is zero. The fall-off in amplitude, shown one way in Fig. 2, appears in Fig. 4 as the decreasing length of the vector when its tip moves around the circle towards O, while the phase shift is indicated directly by its change of direction. And we see that the direction changes quite a lot—say 20°—before the shortening is very noticeable even to the eye. By the time it is noticeable to the ear—say −3 dB, at f_{tu} or f_{tl} (the upper or lower turning frequencies) —the phase shift amounts to 45°, as we have already seen in Fig. 3.

Visible Effects

And now, having collected together our tools and reminded ourselves how they are used, we can start on the job.

The first thing to notice, in reviewing a/f.d. and p/f.d., is that neither of them can distort a single-frequency signal. The essence of both kinds of distortion is that they treat different frequencies unequally, and if only one frequency is present there is nothing that can be unequal. So a sinusoidal waveform cannot suffer from a/f.d. or p/f.d.

But if now we put on a very slightly more entertaining programme, say "Cathode Ray's" *Duet in A Flat for Two Audio Signal Generators*, and if at a given moment the soprano generator is playing a note of a frequency specified in Fig. 2 as "3" and the tenor generator is accompanying it on frequency "1," it is clear that there will be distortion, because the relative strengths of the two notes are upset to the extent of 7 dB. If the passage in question were scored for equal intensities from the two instruments*, the input waveform (assuming zero phase difference at the start) would be as in Fig. 5(a), where one whole cycle is shown. If now the higher tone is reduced by 7 dB the result is Fig. 5(b), which has a markedly different waveform—almost an approximation to a square wave—and distortion can certainly be said to have taken place. But this is not what would be obtained from an actual distorting circuit, for the a/f.d. is inevitably accompanied by p/f.d., with the result shown at (c).

Although (c) *looks* distinctly different from (b), it would sound just the same. So would waveforms with even more striking visual differences. But for

(*Continued on page 191*)

* In "Cathode Ray's" musical works, directions are, of course, given in dB instead of the usual vague terms such as *pp* and *mf*.

Model 1058 Single Beam Oscillograph

Designed for laboratory use, this new oscillograph provides a Y amplifier with a very useful frequency characteristic extending from d.c. to 6 Mc/s. The display is presented on a new post deflection accelerator tube at an amplitude of not less than 6 cm over the stated frequency band. The maximum sensitivity of the channel is 0.25 V/cm and calibration is effected by means of the accurate test voltage provided. The time base of the instrument can be switched to fire repetitively from a trigger pulse of either sign derived from the Y amplifier signal or externally. A special refinement, of interest to the Television Engineer, is the provision for triggering from the Frame or Line sync. pulse in a 1 volt D.A.P. (positive) composite video signal. Five calibrated time base ranges are provided giving spot velocities from 30 cm/sec to 1.5 cm/microsec. An X amplifier with a maximum sensitivity of 0.5 V/cm and bandwidth 20 c/s—250 kc/s (—50%) is included and allows time base expansion, continuously variable, of up to five times. Time measurement is by calibrated shift control. The instrument operates from 100—130 or 200—250 volt mains supplies.

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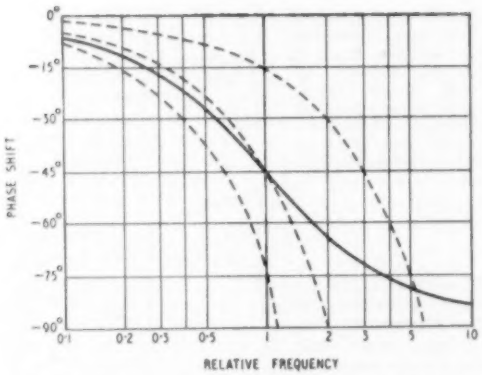


Fig. 7. To the actual phase-shift curve of Fig. 3 are added dotted curves all of which represent zero phase frequency distortion.

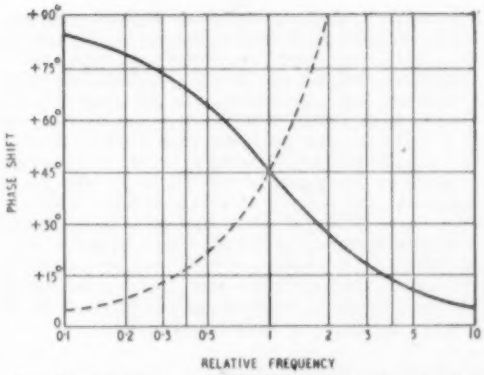


Fig. 8. Whereas the actual phase-lag curve in Fig 7 causes hardly any phase distortion up to the high-frequency cut-off, the phase-lead down to and beyond low-frequency cut-off falls right across the no distortion lines, one of which is shown here.

some purposes, notably television, p/f.d. cannot be ignored. So we are going to switch attention from the well-known a/f.d. to the not quite so well-known p/f.d.

Because a/f.d. is shown on an a/f characteristic diagram such as Fig. 2 as departure from the straight and level, one might suppose that the same applied to a p/f diagram and p/f.d. The fact that the sloping p/f curve in Fig. 3 has certainly knocked the shape out of Fig. 5(b) seems to confirm that. And it is obvious that a perfectly flat p/f characteristic at the zero level indicates no p/f distortion; if there were no phase shift of any of the component parts of a waveform, the whole thing would be left where it was. But it is also true that a waveform is not distorted by being shifted *as a whole*. This matches the fact that altering the amplitude as a whole does not distort—otherwise amplification would by definition be distortion! Any number of no-distortion lines can be drawn on an a/f graph; they can be at any level, so long as they *are* level, showing that the amplitude is changed equally at every frequency.

A Catch

In the same way, presumably, horizontal no-distortion lines can be drawn at any level on a p/f graph, showing that the phase is shifted equally at every frequency? But we presume too much. There is a catch hidden in the word "equally." Fig. 6 will show it more clearly than a lot of explanation. Phase is reckoned in fractions of a cycle, usually in 360ths, commonly called degrees. Waveform (b) is twice the frequency of (a), so has twice as many cycles in a given time, and therefore twice as many degrees. If (b) is added to (a) it sharpens its positive half-cycle and blunts its negative half. Now if (a) is phase-shifted 90° to the left its positive peak is brought to the starting point, and to preserve the same shape wave (b) must be moved to the left an equal *time* interval. But on its phase scale that is 180°. If its *phase* shift were the same as (a)'s its positive peak would not coincide with (a)'s and the composite waveform would be quite different; in a word, it would be *distorted*.

If (b) had been three times the frequency of (a), its phase shift would have had to be three times (a)'s.

On a p/f graph, then, the only no-distortion line that is flat is the one at 0°; all the others must indicate phase shifts *proportional to frequency*. If the shift at the reference frequency (1) is 45° as in Fig. 3, at twice the frequency it must be 90°; at four times, 180°; and so on. Such a curve does in fact follow Fig. 3 fairly closely up to 45° (Fig. 7) although beyond that it goes right off. So although the amount of a/f.d. up to that point, which is usually tolerated, is accompanied by a relatively large amount of phase *shift*, it is not a large amount of phase *distortion*. It looks as if p/f.d. is a negligible factor in the distortion of any waveform by a top-cut circuit having a turning frequency no lower than the highest significant frequency in the waveform; practically all the distortion is a/f.d. That does not, of course, mean that the phase shift of the waveform as a whole can always be ignored, but just that it does not appreciably affect the wave shape.

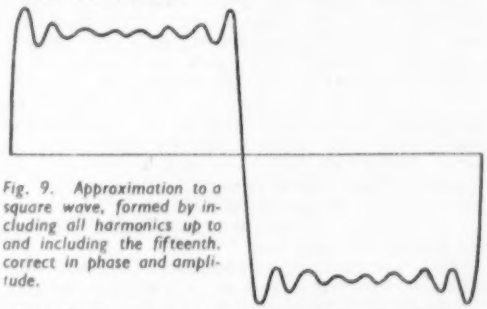


Fig. 9. Approximation to a square wave, formed by including all harmonics up to and including the fifteenth, correct in phase and amplitude.

Having previously noted the mirror relationship between top-cut and bottom-cut circuits, one may perhaps suggest that the same kind of principle applies also to bottom-cut circuits. But no! This is where the symmetry breaks down. As Fig. 8 shows, the leading phase-shift curve corresponding to the lagging curve of Fig. 3 could hardly differ more from the dotted line, which is the no-p/f.d. curve passing through the 45° point. We may expect, then, that visible distortion at the low-frequency end of the band will be worse than at the high-frequency end. Whereas at the h.f. end virtually only the a/f.d. has any effect, at the l.f. end there is a/f.d. plus probably even greater p/f.d.

Just how it works out in practice depends, of course, on the original waveform of the signal, because on that depend the frequencies present and their relative amplitudes and phases. Perhaps the most important waveform after the sinusoid is the square wave. Moreover, distortion of it is easy to see. So it should be a good example for comparing the effects of l.f. and h.f. distortion. For some purposes it is essential to keep its front nearly vertical or its top nearly horizontal, or both. It contains odd harmonics only, up to infinity if the squareness is to be perfect. The third harmonic is one-third the amplitude of the fundamental, the fifth one-fifth, and so on, so the absence of the very high ones is not conspicuous. All the harmonics start off in phase, in order to provide the infinitely steep rise and fall.

Fourier or Oscilloscope

If you are looking for something to while away a very long time (or something to do with your new electronic computer) you can try making up the square-wave recipe just given, adding in harmonics until the result is square enough. Myself, I have never got beyond the fifteenth, and that yields a rather poor apology for a square wave, with a lot of ripples on the supposedly flat top (Fig. 9). One can then (if still in the game) alter the amplitudes and phases in accordance with any desired distorting circuit and note results. Besides being liable to revive the mathematicians' riot that broke out on the appearance last September of "Fourier—Fact or Fiction?" this suggestion will no doubt be rejected as intolerably tedious or expensive—unless the fascination of it gets you.

There are two simpler methods. One is to consider the distorting circuit as a capacitance charging or discharging through a resistance. The other is to connect a square-wave generator to the appropriate distorting circuit and observe the output on an oscilloscope.

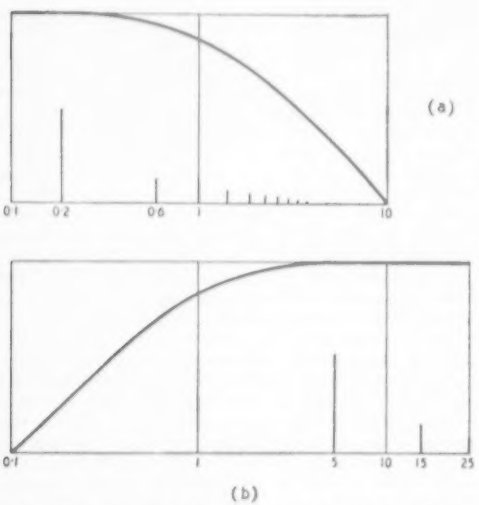


Fig. 10. These two diagrams show the relative amplitudes and frequencies of the first few components of a square wave, in relation to (a) high and (b) low frequency cut-off curves. In (a) the fundamental of the square-wave is one-fifth the cut-off frequency (=.1) and in (b) it is five times, giving the same reduction in amplitude.

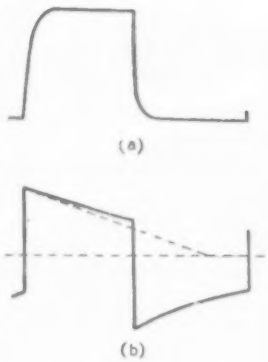


Fig. 11. Oscillograms of square waves distorted by the conditions shown in Fig. 10. Although Fig. 10(a) would suggest much worse distortion than (b), the relatively serious effect of phase-shift in (b) proves decisive.

Fig. 10 shows the basis of the first comparison we shall make. In each case the fundamental, represented by the tallest vertical line, is on the safe side of the turning frequency (1 on the scale) by a 5 to 1 margin. The attenuation and phase shift are therefore the same in both, as regards the fundamental. But as regards the whole series of frequencies in the square wave, the odds appear to be heavily against it in the top-cut case (a), because all the harmonics are lower down the curve than the fundamental; in fact, all except the third and fifth are right outside the accepted frequency band, as usually defined. On the other hand, in (b) all the harmonics are on the safe side of the fundamental, and might be expected to be almost free from distortion.

How does it actually work out? Fig. 11 shows what the oscilloscope reveals when tests are made under the conditions just described. Waveform (a) corresponds to Fig. 10(a), and (b) to 10(b). There is no doubt that the l.f. distortion (b), though under apparently much more favourable conditions, is more visible than the h.f. Which was more troublesome in practice would depend on whether the need was for a steep front or a flat top. In (a), the distortion is due mainly to the weakening of the harmonics, which reduces the steepness of the wave-front. As we saw in Fig. 7, there is very little relative phase shift except at frequencies which are barely represented in the output. In (b), on the other hand, a/f. distortion is almost negligible, and the pronounced tilting of the horizontal parts of the square wave is due almost entirely to the phase-shift of the fundamental relative to the harmonics. An approximation to it can be obtained by adding to a true square wave the *difference* between a sine wave starting at 0° and one starting at 11.3°, both of them having an amplitude $4/\pi$ times that of the square wave.

Square-wave Testing

However fascinating Monsieur Fourier may be, there is no doubt that for square waves the charging capacitor approach is simpler. According to it, the blunting of the wave-front in Fig. 11(a) is caused by the shunt capacitance in Fig. 1 having to charge up before the full voltage can be established across the resistance. The theory of the thing shows that if the rate at which C began to charge were kept up the charging would be completed in CR seconds. Now Fig. 10(a) shows the square-wave frequency f_s to be 0.2 times the turning frequency f_t, which we

know is $1/2\pi CR$. Therefore, CR is $0.2/2\pi f_s$, or $0.2/2\pi$ times the duration of one square-wave cycle, or $0.2/\pi$ or 0.064 times the duration of half a cycle. In other words, if the beginning of the upward rise in Fig. 11(a) were produced until it hit the original perfect flat top, it would do so only about one-sixteenth of the way along it.

The sloping top in Fig. 11(b) is caused by capacitance in series. Ideally, it would not charge at all during half a cycle, but because it is not infinitely great it must charge somewhat. It begins at a rate which, if kept up, would complete the job in CR seconds. Fig. 10(b) shows that the square-wave frequency f_s is 5 times the turning frequency, $1/2\pi CR$. Therefore, CR is $5/2\pi f_s$, or $5/2\pi$ or 0.8 times one cycle. So if the starting slope had continued it would have reached the zero line in less than a cycle, as shown dotted in Fig. 11(b).

This, then, is a very sensitive test of low-frequency loss. By adjusting the oscilloscope so that the square waves are very narrow, it is quite easy to detect a sloping top when the turning frequency is as much as 50 times lower than the square-wave frequency used for testing. In fact, by using a single test frequency of, say, 1,500 c/s one can detect turning frequencies of both 30 c/s and 20,000 c/s, and thereby estimate the effective bandwidth of an audio amplifier. Of course, in complete amplifiers with more than one stage the relationships between a/f and p/f characteristics are more complicated (as we saw in the January issue), but nevertheless the square-wave test at a single frequency—or at the most two frequencies—gives one some idea of the bandwidth, and at the same time shows up any resonances, as ripples on the flat top, and enables one to judge their frequency and damping.

Another thing that emerges from our study is that if we want to preserve a flat top to a square waveform it is certainly not enough to make sure that it is just on the right side of what is usually reckoned as the cut-off frequency. It looks as if, for a 50 c/s square wave, the cut-off frequency ought to be not higher than 0.5 c/s. In other words, the coupling capacitor must be large enough for its reactance to be only about one-hundredth the resistance fed through it—say $3\mu F$ for $100k\Omega$, instead of the $0.1\mu F$ that would do nicely for sine waves. However, if one doesn't like this, alternative dodges can sometimes be used, such as low-frequency boost circuits. But that is another story.

V.H.F. at SEA

By CAPT. F. J. WYLIE,* R.N. (Retd.)

PROPOSALS FOR MARINE RADIO-TELEPHONE SERVICE

TOWARDS the end of last year an international conference was held at Gothenburg, Sweden, to improve marine radio-telephone communication in the Baltic and North Sea. The main work concerned the effective use of the frequency band 1,605 to 3,905 kc/s, which includes the international distress and calling frequency (2,182 kc/s), and an agreement was unanimously adopted by the 13 participating countries. During the conference an informal meeting, attended by all delegates, was held to discuss the use of v.h.f. for the marine mobile services and our contributor, who was an observer for the International Chamber of Shipping, here summarizes the results of the discussions at Gothenburg.

SHIPS of any flag may communicate with each other and with the coast stations of other countries without any difficulty using standardized m.f. and h.f. equipment. With v.h.f. radio-telephony, the situation is very different; services like those offered in the other bands do not exist and the majority of the few ships which do carry v.h.f. equipment, do so for communication within their own companies' networks. The thousands of deep-sea ships which are potential beneficiaries of the advantages of short-range radio-telephony are not equipped because no such internationally agreed service is offered in the ports and on the coasts of the world.

For v.h.f. to be an economic proposition for ships, it is necessary to use broad-band equipment, with crystal switching to change the frequency. This means that a single unit of equipment would have to cover a band of about 2 Mc/s or, preferably, 1.5 Mc/s. More complicated equipment may, of course, be built up of units which together cover a much wider band. Further, to achieve intelligible speech between stations, it is necessary to specify with considerable accuracy a number of technical parameters for the equipment. At the present time, as far as international usage is concerned, no frequency band is defined and no technical characteristics have been agreed. Added to these technical barriers is the lack of international collaboration between governments and the other interested parties.

The shipowners' Radio Advisory Service in the U.K. has been endeavouring for some years to stimulate interest in this matter through both national and international channels. Due in considerable measure to these efforts, opportunity was taken by the delegations at the Baltic and North Sea Radio-telephone (2 Mc/s) Conference at Gothenburg to discuss informally the basic requirements of an international maritime v.h.f. service. Without difficulty, informal agreement was reached on frequency bands (156.0-158.025 and 160.525-162.525), the type of modulation (f.m.), channel spacing† and on a tentative frequency plan giving in general terms the channel

* Radio Advisory Service of the Chamber of Shipping and the Liverpool Steam Ship Owners' Association.

† Initially 100 kc/s, but it is recommended that equipment should be designed for 50-kc/s channel spacing.

Mc/s	Nature of communications
156.1*	Intership, harbour and docking
156.2*	Intership, harbour and docking
156.3†	Intership (First choice)
156.4*	Intership, harbour and docking
156.5*	Intership, harbour and docking
156.6†	Port operations (First choice)
156.7*	Intership, harbour and docking
156.8†	Safety and calling
156.9*; 161.4*	Harbour and docking or public correspondence
157.0*; 161.5*	Harbour and docking or public correspondence
157.1*; 161.6*	Harbour and docking or public correspondence
157.2*; 161.7*	Harbour and docking or public correspondence
157.3; 161.8	Public correspondence (Second choice)
157.4; 161.9	Public correspondence (First choice)

* Single or double frequency operation.
† Single frequency operation only.

allocations (see Table). It is to be hoped that at the VIIIth Plenary Assembly of the C.C.I.R. in Warsaw this summer, there will be equally little difficulty in settling all the other vital parameters.

If this desirable situation is reached, there will then be known all the essential factors for the design of ships' v.h.f. equipment. It then remains for legislation to be made on the facilities to be provided by v.h.f. Administrations will have to assign frequencies and establish public correspondence services and port authorities will (it is to be hoped) offer pilotage, navigational and other services on v.h.f. in the ports of the world.

Perhaps the most vital point which will still remain to be established, is the number of channels which will be needed to operate the international facilities to be offered. One of the principal factors in the cost of the ship's equipment will be the number of channels it must cover. It will be useless to say that the ship should be prepared to use any of the 30 channels made available in a 1.5 Mc/s waveband with 50 kc/s spacing, when the maximum number which any port uses may be found to be 10. On the other hand, it will be equally frustrating for the shipowner to provide his ships with 6-channel equipment to find that the average port uses 12 channels.

This rather simple arithmetic is complicated by the fact that the magic number, when it has been found and agreed, will not only describe the best number of channels for a ship's equipment but will also define the number for which all countries will need to assign the *same* frequencies. The ideal to be aimed at is that a ship of any nationality should be able to close any coast and enter any port and take advantage of any v.h.f. radio-telephone service available, using equipment offered at a reasonable price because it needs to cover only, say, 8 to 12 channels.

The kind of communications in mind are with the pilot vessel, the port radar station, the port traffic authority, the berthing or docking officer and, through public correspondence, perhaps, to owner or agent, fire brigade or police. This is all "ship's business." It is doubtful whether the large volume of passenger radio-telephone traffic could or should be carried on this basic equipment. The peak demands for "ship's business" and passenger calls will synchronize and so must be operated simultaneously in different bands.

It is abundantly clear, first, that the subject of international maritime v.h.f. contains a large number of unsolved problems, most of which will concern at least three of the four main interested parties and, secondly, that the haphazard development from small beginnings, which characterized the growth of the m.f. and h.f. systems, will not be healthy for v.h.f. It is hoped that the Gothenburg informal agreement has set the ball rolling, nationally and internationally, and that by the time the C.C.I.R. has settled the technical parameters, the much needed collaboration between administrations, manufacturers and users will be manifest.

Professional Recording Methods

IN a lecture to the British Sound Recording Association recently W. S. Barrell, B.Sc., of E.M.I. Recording Studios, outlined the development of professional disc recording during the past 30 years and contrasted the heavy gravity-operated direct-recording machines using wax masters with the relatively portable magnetic recorders with which tape masters are now produced. In his view the facility with which these magnetic tapes can be cut and edited has not proved an unmixed blessing. Modern artists seem to have lost the ability to go through even a 4½-minute session without coughing or rustling—an essential qualification for recording in the days of the wax disc.

Lacquer discs are now used in the first step from tape to the record stamper, and an entirely new disc recorder has replaced the older one, using a single-turn moving-coil cutter, which had given long years of service with wax. The new machine incorporates an automatic variable groove-spacing device, and is push-button operated throughout, including the selection of turntable speed and operation of the run-off groove mechanism.

Mr. Barrell made some interesting comments on studio technique in general and expressed the view that no single microphone had so far proved itself suitable for all types of recording. E.M.I. chose the appropriate instrument for any given recording from a range of different types—all with similar measured characteristics. In his view the old E.M.I. (Blumlein) moving-coil microphone was still the best for recording the piano.

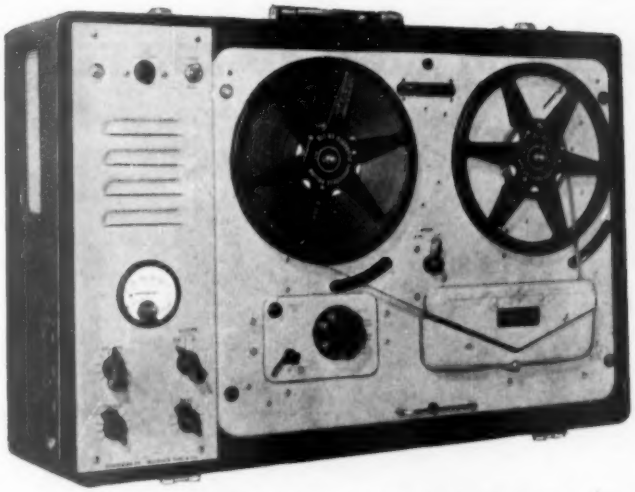
Ionic Fire Alarm

ONE disadvantage of conventional fire indicators and alarms, which depend on a rise of temperature for their operation, is the time delay before the critical temperature is reached, particularly if the indicating device is some distance from the original seat of the fire.

A new method due to E. Meili depends on the reduction by smoke particles and other products of combustion of the current induced in an ionization chamber by a minute radioactive source. To compensate for normal variations due to atmospheric pressure and temperature a second ionization chamber, to which smoke cannot enter, is connected in series with the first to form a potential divider. The change in potential due to smoke is applied to a cold cathode gas discharge triode which operates a relay.

The manufacturers of the system in this country are The Minerva Detector Company, Ltd., Red Lion Street, Richmond, Surrey.

VORTEXION TAPE RECORDER



The amplifier, speaker and case, with detachable lid, measures 8½in. x 22½in. x 15¾in. and weighs 30 lb.

PRICE, complete with WEARITE TAPE DECK £84 0 0

★ The total hum and noise at 7½ inches per second 50-12,000 c.p.s. unweighted is better than 50 dbs.

★ The meter fitted for reading signal level will also read bias voltage to enable a level response to be obtained under all circumstances. A control is provided for bias adjustment to compensate low mains or ageing valves.

★ A lower bias lifts the treble response and increases distortion. A high bias attenuates the treble and reduces distortion. The normal setting is inscribed for each instrument.

★ The distortion of the recording amplifier under recording conditions is too low to be accurately measured and is negligible.

★ A heavy mu-metal shielded microphone transformer is built in for 15-30 ohms balanced and screened line, and requires only 7 micro-volts approximately to fully load. This is equivalent to 20ft. from a ribbon microphone and the cable may be extended 440 yds. without appreciable loss.

★ The .5 megohm input is fully loaded by 18 millivolts and is suitable for crystal P.U.s, microphone or radio inputs.

★ A power plug is provided for a radio feeder unit, etc. Variable bass and treble controls are fitted for control of the play back signal.

★ The power output is 3.5 watts heavily damped by negative feedback and an oval internal speaker is built in for monitoring purposes.

★ The play back amplifier may be used as a microphone or gramophone amplifier separately or whilst recording is being made.

★ The unit may be left running on record or play back, even with 1,750ft. reels, with the lid closed.

POWER SUPPLY UNIT

to work from 12 volt Battery with an output of 230 v., 120 watts, 50 cycles within 1%. Suppressed for use with Tape Recorder. **PRICE £18 0 0.**

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is almost essential for the professional or semi-professional where a number of different items have to be mixed on one tape recording.
It is recommended by a number of tape recorder manufacturers for this purpose.
Any normal input impedance can be supplied to order, balanced or unbalanced, the standard being 15-30 ohms balanced.
The normal output is 0.5 volt on 20,000 ohms or less, but 600 ohms is available as an alternative.
The steel stove enamelled case is polished and fitted with an engraved white panel suitable for making temporary pencil notes.
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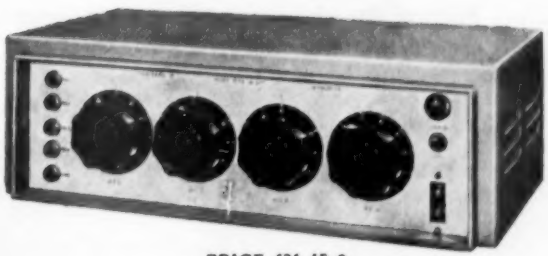

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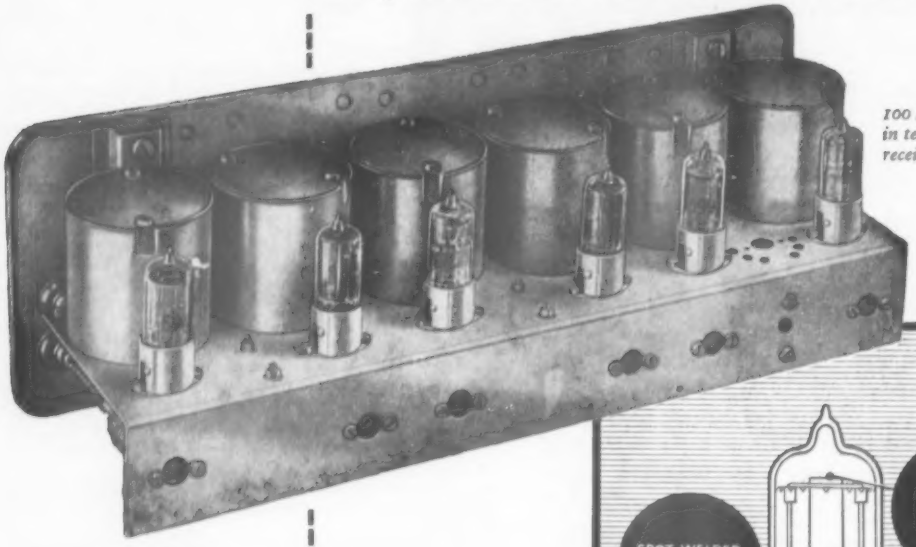
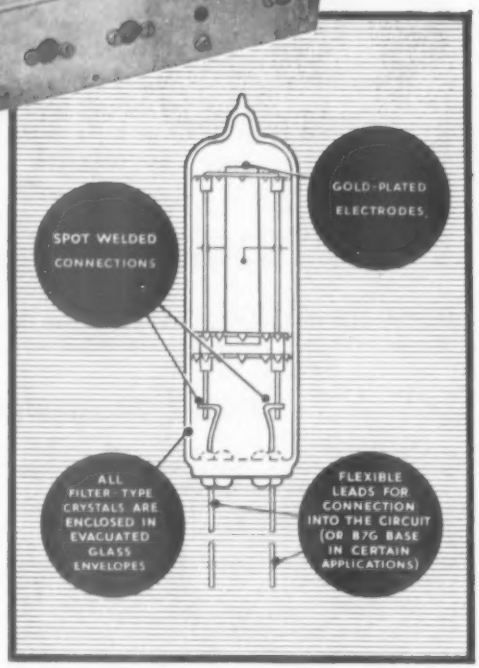
for precision filters 40-700 Kc/s



100 Kc/s crystals in telegraph receiver filter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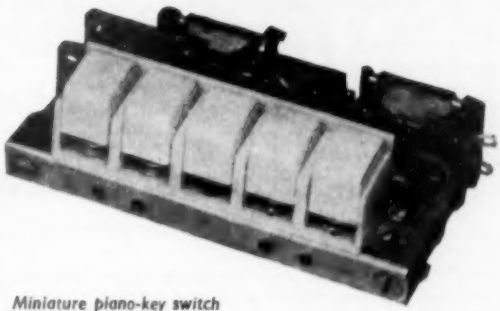
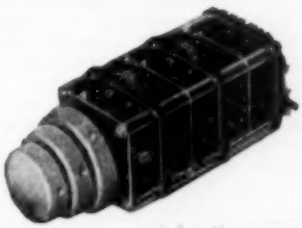
French Components Show

THE accompanying photographs show a few of the more interesting items displayed at the Parc des Expositions, Paris, where the 19th exhibition of radio components, valves, accessories and measuring instruments was held this year. Organized by the Syndicat des Industries de Pièces Détachées et Accessoires Radioélectriques et Electroniques, the show as a whole was notable for being well laid out and decorated, with plenty of space between the stands, and for the novel feature of having a programme of lectures running during exhibition hours.

It was definitely a French national exhibition—there being practically no foreign products on show—and the accent tended to be on "professional" components and accessories, and things designed to satisfy military specifications. However, there was a noticeable increase in new components for f.m. receivers, for multi-channel television sets and for high-quality sound reproduction equipment. Printed



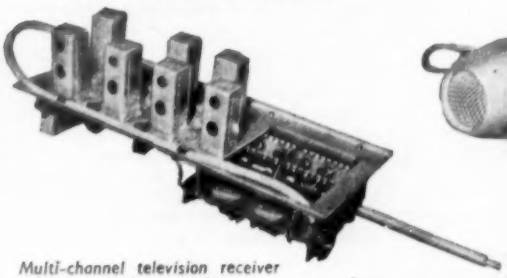
Miniature piano-key switch shown by Optalix.



Triple coaxial rotary switch made by Dyna.

Left: Klystron of 4 megawatts output power produced, mainly for use in linear accelerators, by Compagnie Générale de T.S.F. The height of the valve is about 3 feet.

Left: Microphone incorporating a transistor pre-amplifier, shown by Lemonne.



Multi-channel television receiver "front-end" shown by Cicor.

Television focusing and picture-centring assembly with control by flexible cable, made by Aréna.

Right: An oscilloscope made by Leres. The bandwidth of the Y amplifier is 60 Mc/s.

Left: A miniature gramophone turntable (45 r.p.m.) made by Eden-Dentzer. Right: The same equipment in a small portable record player by Clement, using a transistor amplifier (OC70, OC71 and two OC72s) and powered by four 1.5-V torch batteries. The size of the exhibits can be seen from the copy of our French contemporary, Toute La Radio, underneath.

circuits were very much in evidence and also miniature components for use with transistors. The outstandingly original development work done by the French on velocity-modulation valves for s.h.f. was represented by new types of "Carcinotrons" (backward-wave oscillators) for operation in radar equipment.

The subjects of the lectures (18 in all) gave additional emphasis to the "non-entertainment" tone of the exhibition—magnetic recording in the field of information; new forms of construction for electronic circuits; magnetic materials (in particular, ferrites); semi-conductor devices and their influence on component design; methods of control in the manufacture of components. The final address, by an official of the industry, gave an account of the work which is being done in France to establish proper specifications for radio components.

Instructional Films on Waveguides

Colour Animation as an Aid to Teaching

ANYONE who has ever attempted to explain the principles of waveguides will hardly need convincing of the value of animated film as a teaching aid. Without movement, the most skilfully drawn diagrams call for a considerable effort of imagination on the part of the trainee, and the instructor is not always fortunate enough to be able to count on this. The appearance of a set of five films developing the subject clearly and logically from the basic principles of electric and magnetic fields is therefore most welcome. They are 16-mm sound films in colour—practically essential for distinguishing the fields—produced by Science Films, Ltd., for the Royal Air Force, but are available to the other Services and to technical colleges, etc.; inquiries should be addressed to Air Ministry (S.T.4), London, S.W.1.

Each film runs for about 20 minutes, and is intended to be shown at an appropriate point in an extended course of instruction. Because of the heavy cost of animated film in colour, they are highly concentrated and need to be supplemented by a considerable amount of classwork; for the same reason it would be most desirable for trainees to see each one at least twice.

Part I ("Guiding Electromagnetic Waves") starts from the propagation of transverse electromagnetic waves along two-conductor transmission lines, and indicates the desirability, for microwaves, of reducing losses by removing the inner conductor of a coaxial cable, with its solid supports; but propagation of such waves then becomes impossible owing to boundary conditions being wrong.

Part II ("Bouncing Waves") continues the story by showing that the introduction of a longitudinal component of either electric or magnetic field, so that the waves are reflected alternately from top and bottom of the guide, sets up acceptable boundary conditions. The resulting field patterns and their motions are then developed. This is undoubtedly the key film in the series and the one in which animation is most helpful.

Part III ("E and H Waves, Launchers and Slots"). From the H_{01} rectangular mode in Part II, the other modes are distinguished, and factors governing the choice of waveguide dimensions are explained. Animation again results in a particularly effective treatment of launching probes. Wall currents are considered, and their bearing on radiating and non-radiating slots.

Part IV ("Resonant Cavities, Joints and Stubs"). The production of standing waves by reflection from a closed end of a guide is shown by superimposing animated diagrams, and the length of guide is successively reduced until it is no more than a resonant cavity. Next come the techniques necessary for feeding a rotating aerial—choke joint, undesired-mode suppression, etc.—and series and shunt stubs are explained by analogy with transmission lines.

Part V ("Irises and other Matching Devices; Common T and R Systems"). This film falls into three sections: the first, dealing with irises, screws and dielectric rod matching devices, consists largely of pictures of the devices included, with little animation or development from basic principles; the second makes better use of the medium in explaining common T and R systems; and the third is a recapitulation of the four preceding films.

Thoughout, particular care is taken to link the theoretical explanations with practical application in radar installations. The tempo of the exposition seems to vary somewhat from section to section, but this—and the impression that fields consist of lines—can no doubt be corrected by the instructor. There are one or two slight inaccuracies in the delineation of the fields. On the whole, though, all concerned in the production of these films are to be congratulated on an excellent job and a valuable addition to teaching facilities.

M. G. S.

A.R.R.L. Handbook

THE 33rd edition of The Radio Amateur's Handbook now available has been considerably revised and its 26 chapters reflect the most up-to-date techniques in amateur radio communication and frequency measurements. Some of the new equipment has a particular appeal to the beginner, but this is not at the expense of the advanced amateur as space has been made for it by omitting obsolete designs.

The tables of valve and semi-conductor data cover 39 pages and are right up to date. Much of this information is not available elsewhere in such easily assimilated form.

Compiled by the headquarters staff of the American Radio Relay League the handbook contains 608 pages of text, charts and illustrations, plus a 13-page index. It costs 30s (32s by post) in the U.K. and is obtainable from the Radio Society of Great Britain, New Ruskin House, Little Russell Street, London. W.C.1, or from The Modern Book Co., 19-23, Praed Street, Paddington, London, W.C.1.

"Magnetic Tape Amplifier"

In Fig. 1, p. 120, of the March issue, the lower end of P3 should be joined to the junction of C14 and R13; on p. 122, col. 2, line 52, R43 should be R38; on p. 123, col. 2, line 10, R4 should be R5 and on p. 124, col. 2, line 27, the series grid resistor and not R9 should be 1 MΩ.

APRIL MEETINGS

LONDON

4th. I.E.E.—"The Crystal Palace television transmitting station" by F. C. McLean, A. N. Thomas and R. A. Rowden; "The Broadcasting House—Crystal Palace television link" by Dr. A. R. A. Rendall and S. H. Padel; and "Band I television transmitter design with particular reference to the transmitters at Crystal Palace" by V. J. Cooper and W. J. Morcom at 6.15 at Savoy Place, W.C.2.

6th. Brit.I.R.E.—Discussion on "The importance of visual aids in the teaching of advanced radio and electronic engineering" opened by R. H. Garner at 6.30 at the School of Hygiene and Tropical Medicine, Keppel Street, W.C.1.

6th. Television Society.—"Television transmitter design" by V. J. Cooper (Marconi's) at 7.0 at 164 Shaftesbury Avenue, W.C.2.

9th-14th. I.E.E.—Convention on digital-computer techniques at Savoy Place, W.C.2.

19th. Television Society.—"Recent progress in transistors with reference to television" by J. H. Barry, A. E. Jackets and D. D. Jones (G.E.C. Research) at 7.0 at 164 Shaftesbury Avenue, W.C.2.

20th. B.S.R.A.—"Magnetic tape as a control medium for machine tools and allied equipment" by D. T. N. Williamson at 7.15 at the Royal Society of Arts, John Adam Street, W.C.2.

23rd. I.E.E.—"Automatic assembly systems for electronic equipment" by G. W. A. Dummer at 5.30 at Savoy Place, W.C.2.

25th. Brit.I.R.E.—"Radio and television interference—its growth and effects" by M. Smith at 6.30 at the London School of Hygiene and Tropical Medicine, Keppel Street, W.C.1.

26th. I.E.E.—"Radio astronomy" by Professor A. C. B. Lovell at 5.30 at Savoy Place, W.C.2.

BIRMINGHAM

23rd. I.E.E.—Annual general meeting of South Midland Radio Group, followed by "F.M. broadcasting and reception" by H. E. Farrow at 6.0 at the James Watt Memorial Institute, Great Charles Street.

BRISTOL

10th. Television Society.—"Oscilloscopes" by T. S. Whish at 7.30 at the Hawthorns Hotel, Woodland Road.

GLASGOW

11th. Brit.I.R.E.—"Glasgow University synchrotron: its principles and application" at 7.0 at the University's Department of Natural Philosophy.

MALVERN

9th. I.E.E.—Informal discussion on technical education to be opened by Dr. K. R. Sturley and C. F. Partridge at 7.30 at the Winter Gardens.

MANCHESTER

5th. Brit.I.R.E.—"Design of an underwater television camera" by D. R. Coleman and D. Allanson at 6.30 at Reynolds Hall, College of Technology, Sackville Street.

11th. Television Society.—"Cathode-ray tubes for television" by M. D. Dudley (Ferranti) at 7.30 at the College of Technology.

18th. Television Society.—"Some problems of a band-sharing colour television system" by A. V. Lord (B.B.C. Research) at 7.30 at the College of Technology.

PORTSMOUTH

11th. I.E.E.—Annual general meeting of Southern Centre followed by discussion on "Soldered joints" opened by W. Ford, at 6.30 at the College of Technology Extension, Anglesea Road.

WEYMOUTH

13th. I.E.E.—"Application of electronics to accountancy" by W. Woods-Hill at 6.30 at the South Dorset Technical College.

MAY MEETINGS

LONDON

9th. I.E.E.—"Time sharing as a basis for electronic telephone switching: a switched highways system" by L. R. F. Harris at 5.30 at Savoy Place, W.C.2.

9th. Royal Society of Arts.—"Automation" by the Right Hon. the Earl of Halsbury (National Research Development Corporation) at 2.30 at John Adam Street, W.C.2.

14th. I.E.E.—Discussion on "An elementary presentation of the principles of magnetism and electromagnetic induction, with demonstrations" opened by Professor K. A. Hayes at 6.0 at Savoy Place, W.C.2.

16th. Royal Society of Arts.—"Electronic photography" by Commander C. G. Mayer (R.C.A.) at 2.30 at John Adam Street, W.C.2.

23rd. Brit.I.R.E.—"The measurement of the velocity of 'light' by electronic methods" by Dr. K. Froome at 6.30 at the School of Hygiene and Tropical Medicine, Keppel Street, W.C.1.

25th. B.S.R.A.—"Description and demonstration of the B.B.C. (Type DRD 5) fine groove reproducing desk" by H. J. Houlgate, followed by a recital of unusual recordings from the B.B.C. archives presented by T. H. Eckersley at 7.15 at the Royal Society of Arts, John Adam Street, W.C.2.

BIRMINGHAM

2nd. Junior Institution of Engineers.—"Electronic control—the new power in industry" by J. A. Sargrove (Automation Consultants and Associates) at 7.0 at the James Watt Memorial Institute, Great Charles Street.

GLASGOW

2nd. I.E.E.—"The search for and salvage of the Comet aircraft near Elba" by Commander C. G. Forsberg and G. G. MacNeice at 7.0 at the Institution of Engineers and Shipbuilders, 39 Elmbank Crescent.

STAFFORD

4th. I.E.E.—"Germanium and silicon power rectifiers" by T. H. Kinman, G. A. Carrick, R. G. Hibberd and A. J. Blundell at 7.0 at the Technical College.

TORQUAY

10th. I.E.E.—"Radio astronomy" by A. B. Thomas at 3.0 at the Electrical Hall.

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RANDOM RADIATIONS

By "DIALLIST"

Aerial Adventures

I LEARN from readers writing in response to my request for information on f.m. and television reception that a variety of v.h.f. signals are being received on all kinds of apparently quite unsuitable aerials. Good f.m. reception from Pontop Pike on a channel-5 television aerial is more or less commonplace, and at greater ranges than I'd expected. Reports are reaching me of good signals from the channel-8 Lichfield I.T.A. transmitter received on channel-4 Sutton Coldfield aerials. That's not, perhaps, very surprising. The mid-frequency of channel 4 is 60Mc/s and that of channel 8 is 188Mc/s—very nearly an exact multiple. And though the London I.T.A's mid-frequency of 193Mc/s is much further from being an exact multiple of the B.B.C's 43.5Mc/s, a good many living in the London area tell me that they receive the Band III programmes quite happily on their Band I aerials. A Brentwood reader has outdone the lot by receiving the sound part of the vertically polarized I.T.A. transmissions on his horizontal Wrotham aerial! As I said, a month or two since, queer things can happen to the polarization of these waves. Reverting to Band III reception on Band I aerials, it'll be interesting to hear in due course how those using Holme Moss aerials (mid-frequency 50Mc/s) get on with Winter Hill (mid-frequency 193Mc/s). They should manage pretty well at shortish ranges, I think.

A Crying Need

A PROBLEM that should be tackled firmly—and right speedily—by the radio industry is that of radiation from the line timebases of television receivers. Quite apart from its effects on other TV sets, this radiation is responsible for more than 10 per cent of the cases of interference with ordinary sound reception investigated by G.P.O. engineers. The radiation takes place during the line flyback. No visible interference occurs in one's own set, since the brightness is (or should be) below black level at the time. Nor do neighbouring sets normally affect each other if they are tuned to the same transmitter; the flyback occurs at the same instant in all of them and all are then blacked out. But matters are very different if one viewer is watching a B.B.C. programme and a neighbour switches to the I.T.A. station. The flybacks then occur at different times and one far-too-common result is the appearance of a vertical bar on the screen.

No Half-measures

It's no good trying to find palliatives. So long as strong radiation takes place from the line timebase, interference between TV receivers tuned to different stations is bound to be experienced. Even if the two stations used the same aerial mast and a common master scanning generator, there'd still be trouble. What, for instance, would happen if the B.B.C. station were relaying a distant outside broadcast and by means of "Genlock" had tied its waveform generators to the O.B. apparatus? The evil will have to be tackled at its roots and means found of reducing the radiation to harmless proportions. One thing that surprises me is that I don't recall having seen in any American publication, technical or lay, reference to line timebase radiation interference despite the variety of programmes (I supose I ought to write "programs"!) radiated in the big towns. Is one wrong in concluding that American TV set manufacturers have found ways of limiting radiation during the line flyback to something quite innocuous?

Reduced Handyman Outfit

DURING the years in which I lived at no great distance from London I was able to build up a combined lab-workshop so well found that it contained a useful selection of the instruments and the tools needed for dealing with receiver construction, tests, experiments and repairs, as well as with the domestic jobs that come the way nowadays of anyone who is (or thinks he is) any kind of handyman. And then fate decided that I should cease to be a householder and should be on my rather lonely own as the tenant of part of someone else's house. It was clearly impossible to keep the entire contents of the lab-workshop, for there'd be nowhere to put them or use them. I wonder if, in a similar quandary, you'd have come to the decisions

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RADIO INTERFERENCE SUPPRESSION: As Applied to Radio and Television Reception. G. L. Stephens, A.M.I.E.E. 2nd Edition	10/6	11/1
SOUND RECORDING AND REPRODUCTION. A B.B.C. Engineering Training Manual. J. W. Godfrey and S. W. Amos, B.Sc. (Hons.), A.M.I.E.E.	30/-	31/-
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FOUNDATIONS OF WIRELESS. M. G. Scroggie, B.Sc., M.I.E.E. 5th Edition	12/6	13/6

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that I made. My lathe, drilling machine, oscilloscope and valve-voltmeter have fallen by the way. Good homes, I may mention, have been found for all of them. All that I've kept is a useful selection of small tools and appliances. Among these are two high-quality multi-range measuring instruments, an electric drill with a complete outfit of Morse "twists" from 0 to 60, a drill-plate, assorted pliers, various files, a wire-stripper, box spanners and screwdrivers ranging from the jeweller's to one with a blade ¼in wide. So far, these have helped to do all the necessary jobs. Can you suggest any omission?

Modernization

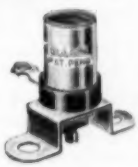
IN my new home I've had all the electric wiring done, or re-done (and some of it badly needed that!) on the ring-main system with the latest kind of 13-ampere outlets for anything that is meant to be plugged into a socket. I'm delighted with the simplicity, the neatness and the safety of the whole installation. Particularly am I pleased with the plugs (3-pin, of course), which contain not only the fuse appropriate for the apparatus to which they're attached—3A, 7A or 13A, as the case may be—but also a small, but quite effective, switch in the phase lead. It breaks all loads up to 13A without any fuss and you can be sure that apparatus left plugged in but switched off is in a perfectly safe condition. Both my sound and TV receivers have their plugs (fused 3A) so connected that the chassis are neutral. When I switch off at the plug or at the set I know that they're electrically inert. They are, in fact, about as safe, whether working or not, as electrical apparatus can be.

It'll Be Welcome

THOSE who live on or near the East Anglian coast hardly know what it is nowadays to receive a B.B.C. sound programme free from interference. Direct intrusion of foreign stations, ear-splitting heterodynes and the maddening signals from radio beacons all play their horrid parts in ruining reception. Very rarely can one use one's set as a means of entertainment. Many people seldom switch on except to hear some important item of news or to get the sports results. The Norwich (Tacolneston) f.m. station is due on the air in a few months now. And won't it just be welcome!

MES
MINIATURE EDISON SCREW

(TO B.S. 98/E.10)



Bulgin Pilot Lampholders to accept Miniature Edison Screw-cap lamps are manufactured to B.S. 98/E.10 specifications and to the usual high Bulgin standards, using the finest available materials. The range is vast and further special types and finishes (*such as RCS.1000*) can be made to quantity orders.

STEEL SPRING helix-"shell" extending upon tightening the lamp; gives vibration-resisting grip. Illustration shows flat-arm bracket.

M.S.T. HOLDER with Cadmium-plated clip. Open-"shell" for normal M.E.S. cap lamps. Available with many other brackets and clips.

MOULDED-BASE Model. Moisture resisting. Heavily plated. Lamp-pip connection is by sprung-plunger with integral tag.

ROLLED-SHELL types. Illustration shows model without bracket, but with rubber grommet for fitting directly to chassis, etc.

DECORATION LAMPHOLDER. Insulated shroud of P.V.C., normally supplied black, but available in many other colours to quantity orders.

BELL-MOUTHED version of the model above. Normally hung in a run of wiring but may be wedged in ¼in. diam. hole.

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UNBIASED

By FREE GRID

When, Whence, Whither, Who?

WE all know when wireless telegraphy was born, but I have been having great difficulty in finding out when, whence, whither and by whom the first message was sent by wireless *telephony*. It was obviously long after Marconi's pioneer days, as c.w. had to be invented first, and that reminds me, I don't even know the when and who of this.

The birth of radiotelephony was certainly in pre-valvular days. I don't mean before November 16th, 1904, but before the valve came into use as a generator of oscillations. I seem to recollect somebody in the early c.w. days sticking a prodigious number of parallel water-cooled microphones in series with the aerial, the paralleling being necessary so that they could handle the large power without burning out too soon. But apart from this hazy recollection I am as ignorant as old Kaspar was about the battle of Blenheim, and I hope you can do more to satisfy my thirst for knowledge than he could for little Peterkin.

Art or Science?

THE word "art" has often been used in the editorial columns to describe wireless or electronics and I am sorry to see in the January issue that it has caused distress to one reader who wants the word banned in favour of "science." He says that the true engineer should be able to deduce by scientific reasoning why or why not a circuit is good.

Maybe he can nowadays, but I am quite certain that this was not so in the hit-and-miss days of thirty years ago. It was then a fine art to get a super-regenerative receiver to function satisfactorily and steadily, and those who could do it were few and far between. I met some of them but not one could explain how he did it any more than Rembrandt in his day could explain his skill with the brush.

A super-regenerative receiver of the early twenties was more unpredictable and capricious than a woman. In fact a well-known psychiatrist of the period, who was also in the front rank of radio experimenters, told me that he had observed that men who could tame a "super-regen." also had a wonderful way with women. That, as you will remember, was an achievement that even excited the obvious envy of Solomon, despite all his wisdom and experience.

Both equally intractable.

Nowadays, of course, the art of "super-regen." control has been developed into a science and anybody can learn how to make one of these formerly intractable receivers eat out of his hand, but the taming of women still remains an art known only to the few like Petruchio. Even this may one day become an exact science.

The truth is that all branches of science start as an art in which only the chosen few, gifted with a strange intuitive genius, are proficient. Eventually knowledge is painfully acquired and becomes available to all who care to study, and so the former art becomes a science. I regard radio as just emerging from the chrysalis state of art, but until it has fully done so it is incorrect to call it by either name.

Wireless in the Wilds

I WONDER if any of you who live within comfortable range of one of the B.B.C. transmitters and are able to sit back and really enjoy the programmes ever spare a thought for those less fortunately situated in the wilds of Wales or Scotland—or even of England—whose listening is punctuated by fading, distortion and "noises off."

It is for these people that the B.B.C. has embarked on its v.h.f. service and it hopes—somewhat optimistically in my opinion—eventually to give "local station" reception to over 90 per cent of the population by this means. To give equal results to the remaining 10 per cent would need a very great and expensive extension of the v.h.f. service.

For a long time past I have thought that the real solution to the problems of those who find themselves left out in the listening jungle is for communities to erect their own fly-power v.h.f. station which would be linked to the B.B.C. network by a landline rented from the G.P.O. In certain cases—such as in the Western Isles—each transmitter would have its own diesel-powered generating unit.

It would be hopeless to try to erect and operate such a station on a basis of voluntary subscription, especially in Scotland. The only real solution to the problem would be for the thing to be run by the local council along with other public services at a cost of no more than a few bawbees added to the local rates.

Robinson Crusoe's Radio

MANY people have told us, in the old desert-island discs programme, what sort of records they would take with them if sentenced to spend a period of solitary confinement on a desert island. Nobody but myself, however, seems to have thought of what sort of wireless set they would take in similar circumstances. Desert islands are usually situated in remote localities, but a good s.w. receiver would bring in all the music the heart could desire.

Desert island delights.

The only snag is l.t. and h.t. supply. One could take enough spare valves and components to last a lifetime, but spare dry cells would soon dry up, as desert islands seem to be always in tropical seas. Accumulators and a wind-driven generator wouldn't do as, no matter how carefully tended, the plates of the cells would eventually disintegrate in the course of a life sentence.

I would be chary of trying to store even "inert" dry cells in tropical regions. I think my solution—laugh if you will—would be a large quantity of the old-fashioned wet Leclanché cells which we used to employ for our domestic electric bells in days of yore; in some districts they are still in use. It would be easy to take a large supply of spare zinc rods or even porous pots. But there is one point on which I need the advice of you battery experts. Should I need to take sacks of spare sal-ammoniac, which is ammonium chloride, or could I use sodium chloride, or in other words sea water? The ideal source of power in such circumstances would be solar batteries but as far as I know they are not yet in production.

TRADITION

IN A YOUNG INDUSTRY

The oldest high fidelity amplifiers in the world are of LEAK manufacture. In 1945 as the result of war-time research in our laboratory we were able to offer, to an astonished world of audio engineers, amplifiers with a distortion content as low as 0.1%. A survey of engineering literature will confirm that we were the first manufacturers in the world to design and market amplifiers with such a small distortion content, and the magnitude of this advance can be gauged when it is remembered that the then accepted standard for **laboratory** amplifiers was 2% distortion. Our figure of 0.1% was received with incredulity, but it was subsequently confirmed by the National Physical Laboratory and this criterion is still an accepted world-wide standard.

With this clear lead on ow-distortion amplifiers we were able to build up an export market much greater than the domestic one, and the increased volume of manufacture resulted in lower prices, which, in turn, brought real high fidelity amplifiers within the reach of the music-lover at home.

We have devoted 21 years entirely to the development and manufacture of audio products and we are proud of our position as the leaders in this field. We are also proud of the fact that the " Point One " amplifiers supplied to our first customers are still giving them results which, even now, cannot be surpassed. Our research and development departments are ever active, our pre-amplifiers have been redesigned for use with the latest input devices, and we have made great progress in the war on prices. From long experience, by the employment of new techniques and by extreme attention to design details during development work on the pre-production models, we enable our labour force to achieve a high output per man-hour. The labour costs thus saved offset the increased costs incurred for high-grade materials, components and finishes, and this together with quantity production (made possible only by a world-wide market) explains how quality products may be sold at reasonable prices.

To our old customers we give our thanks for their support and recommendation—the basis on which our Company has grown. Those who are seeking to obtain the highest quality of gramophone and radio reproduction would be wise to hear and inspect LEAK products which, with their tradition of excellence, represent the best that can be obtained; used by the B.B.C. and overseas broadcasting companies and recording studios throughout the world.

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HIGH FIDELITY EQUIPMENT

LEAK TL/10 AMPLIFIER & 'POINT ONE' PRE-AMPLIFIER

27 gns. *complete*

POWER AMPLIFIER

Circuitry
A triple loop feedback circuit based on the famous TL/12. The output transformer is the same size as in the TL/12.

Maximum power output: 10 watts.
Frequency Response: ± 1 db 20/cs to 20,000 c/s.
Harmonic Distortion: 0.1%, 1 000 c/s, 7.5 watts output.
Feedback Magnitude: 26 db, main loop.
Damping Factor: 25.
Hum: —80 db referred to 10 watts.
Loudspeaker Impedances: 16 ohms, 8 ohms, and 4 ohms.

The products we manufacture are:
Amplifiers
Dynamic (Moving-Coil) Pickups
F.M. Tuner Units
and later in 1956 a loudspeaker system incorporating a balanced push-pull electrostatic treble loudspeaker unit.

★ *Write for leaflet W* ★

"POINT ONE" PRE-AMPLIFIER

The handsome gold escutcheon plate contributes to the elegant appearance and blends with all woods.

★ **Pickup**
The pre-amplifier will operate from any pickup generally available in the world. A continuously variable input attenuator at the rear of the pre-amplifier permits the instantaneous use of crystal, moving-iron and moving-coil pickups.

★ **Radio**
The radio input sockets at the rear permit the connection of the LEAK V.S. tuner unit. An input attenuator is fitted. H.T. and filament supplies are available from the pre-amplifier.

★ **Distortion**
Of the order of 0.1%.

★ **Hum**
Negligible, due to the use of recently developed valves and special techniques.

★ **Input selector**
Radio, tape, records; any and all records can be accurately equalised.

★ **Treble**
Continuously variable, + 9 db to —15 db at 10,000 c/s.

★ **Bass**
Continuously variable + 12 db to —13 db at 40 c/s.

★ **Volume Control and Switch**
The switch controls the power supply to the TL/10 power amplifiers.

★ **Tape Recording Jacks**
An exclusive feature. Readily accessible jacks are provided on the front panel for instantaneous use with Tape Recorders which have built-in (low level) amplifiers.

ELECTROSTATIC LOUDSPEAKERS

Reprints of "The Gramophone" article (May, 1955), by H. J. Leak, summarising his work and findings on Electrostatic and Dynamic Loudspeakers, are available on request, free of charge.

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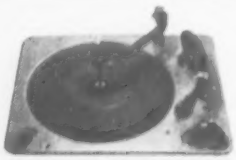

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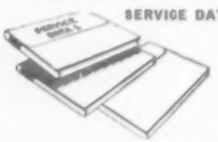
Latest types by all famous makers are invariably in stock at competitive prices. B.S.R., Monarch, Garrard, etc. Latest models from **£7/19/6**, plus 5/- carriage and insurance.

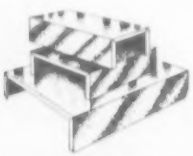
F.M. TUNER

This tuner is based upon the very successful circuit in the booklet published by Data Publications. We have made up models at all branches and will be glad to demonstrate. Cost of all parts including valves, prepared metal chassis, wound coils and stove enamelled scale, slow motion drive, pointer, tuning knob, in fact everything needed to make the complete unit, is **£6/12/6**. Data is included free with the parts or is available separately price 2/-.

SERVICE DATA



100 service sheets, covering British receivers which have been sold in big quantities, and which every service engineer is ultimately bound to meet. The following makes are included: Aerodyne, Alba, Bush, Cossor, Ekco, Ever-Ready, Ferguson, Ferranti, G. E. C., H. M. V., Kolster-Brandes, Lissen, McMichael, Marconi, Mullard, Murphy, Philco, Philips, Pye, Ultra. Undoubtedly a mine of information, invaluable to all who earn their living from radio servicing. Price **£1** for the complete folder. **Our Folder No. 2** consists of 100 data sheets covering most of the popular American T.R.F. and superhet receivers, "all dry," etc., which have been imported into this country. Names include Sparton, Emmerson, Admiral, Crosley, R. C. A., Victor, etc. Each sheet gives circuit diagrams and component values, alignment procedure, etc., etc. Price for the folder of 100 sheets is **£1**. Post free.



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7 × 3½ × 2	3/9	14 × 10 × 3	7/9
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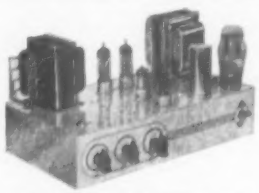
DASHPOT DELAYED CONTACTOR

American make type No. R.91D. This has adjustment to delay opening and closing, and has secondary contacts suitable for heavy currents operating coil; 110 v., 50 cycles. Price **37/6**.

VACUUM RELAY

American made type No. C.61610, this is a relay completely sealed in a glass envelope. It will close in a strong magnetic field or by a coil placed close to or round one of its arms. Price **49/6**. Operating coils **25/-** each.



MULLARD AMPLIFIER "510"

A High Quality Amplifier designed by Mullard engineers. Robust high fidelity with a power output exceeding 10 watts and a harmonic distortion less than 4% at 10 watts. Its frequency response is extremely wide and level being almost flat from 10 to 20,000 C.P.S.—three controls are provided and the whole unit is very suitable for use with the Collaro Studio and most other good pick-ups. The price of the unit completely made up and ready to work is **£19/10/-**, plus 10/- carriage and insurance. Alternatively, if you wish to make up the unit yourself we shall be glad to supply the components separately. Send for the Mullard amplifier shopping list.

BAND III CONVERTER

ADDITA—Many hundreds in use

Any television receiver, whether superhet or straight A.C. or A.C./D.C., home constructed or factory built, which at present will receive B.B.C. will also receive I.T.A., if this converter is added. No modifications at all are necessary to the receiver. Simply plug in the aerial leads and connect to A.C. mains. The converter is in a neat metal case with provision for fixing to the side or the back of the set. Price **£6/10/-**, or H.P. terms available on request if required.

BUILD YOUR OWN CONVERTER

You can save at least £2 on the above if you build the converter yourself. Price of all components including stove enamelled case and even transfer for the front is **£3/10/-** or **£4/10/-** if mains components also required. Data is included free with the parts or available separately price **2/6**.

BAND III FILTERS

To eliminate patterning and other interference. Two models—one high-pass cuts out frequencies above 69 m/s., the other low-pass cuts out frequencies below. Price **27/6** each, postage 2/6.

RECORD PLAYER FOR £4/10/-

3-SPEED INDUCTION MOTOR

3-speed motor with metal turntable and rubber mat. Latest rim drive with speed selection by knob at the side.

HI-FI PICK-UP

Using famous Connocord Hi-G turnover crystal. Separate sapphire for each speed. Neat bakelite case with simple adjuster for weight compensation.

SPECIAL SNIP OFFER THIS MONTH

The two units for **£4/10/-**, or **30/-** deposit and four payments of **18/-**, post and insurance, 5/-. **Or fitted upon base, as illustrated, £5/10/-**, plus 7/6 post and insurance.

LIGHTING SNIP

New perfect fluorescent tubes by famous maker—5 feet 90 watt standard B.C. fitting, 9/6; 4 feet 40 watt standard two-pin fitting, 8/6. Post and insurance and carriage 1/- per tube. **Minimum quantity dispatched 1 doz.**

CABINETS FOR ALL

WE CARRY A VERY VARIED STOCK PLEASE CALL

The one illustrated is the "Empress." It is undoubtedly a beautiful piece of furniture. It is elegantly veneered externally in figured walnut, internally in white sycamore. The radio section is raised to convenient level but is not drilled or cut. The lower deck acts as the motor board, again is uncut, it measures 16 × 14 and has a clearance of 5in. from the lid. There is a compartment for the storage of recordings. Overall dimensions of this essentially modern cabinet are 3ft. wide, 2ft. 8in. high and 1ft. 4½in. deep. Price **£14/14/-** carriage and insurance 20/-.

TOWARDS AUTOMATION

Rotary switch—Ministry Ref. No. AP37579, this is a motor driven switch, the driving motor being a synchronous type for working on 110 volts 50 cycles. The two switches have 20 positions each and are enclosed by a Perspex fronted lid. Separately operated relays providing interlocks. Price **£4/17/6** each.

30 AMP ROTARY SWITCHES

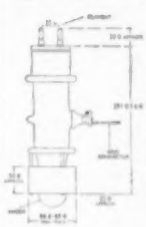
A very robust switch, made by one of our most famous firms. Will give lifetime of service. Price complete with pointer knob. 4 pole change over, **10/-**. 6 pole change over, **17/6**. D.P. on/off 15 amp., **4/6**.

HIGH WATTAGE LAMPS

All G.E.S. Base

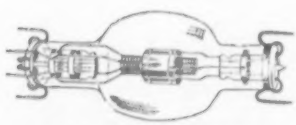
1,000 watt, 230 v., **7/6**. 1,500 watt, 230 v., **9/6**. 400 watt (fluorescent), **17/6**.

SPECIAL PURPOSE VALVES



Triode Type CV 1098 this is a high-power air-cooled triode. Specification of which is as follows: Filament voltage 8.9 v., filament current 35 amps., anode dissipation 750 watts.

This valve is very suitable for R.F. heating at high frequencies and two of these in push-pull under Class C conditions would have an output of approximately 2 kilowatts. Brand new, still in original shockproof packing, price **£5** each. Carriage and insurance 10/-.



TETRODE TYPE VT31

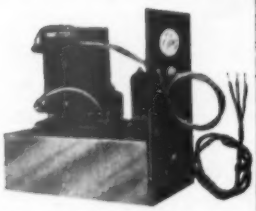
This is a high-powered air-cooled tetrode. Specification of which is as follows:—Heater volts 11.25, heater current 6 amp., maximum anode voltage 5 kV., anode dissipation 250 watts, size approximately 14½in. long and 6½in. across the bulb.

Limited quantity only at £4 each, still in original packing. Carriage and ins. 10/-.

THIS IS ON OFFER AT APPROX. HALF COST TO MAKE

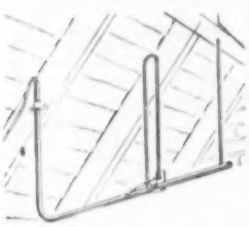
An impressive costly looking cabinet originally designed for T.V. but simple modification makes the cabinet suitable for radiogram, amplifier, tape recorder, or reflex speaker—size 23in. wide, 29in. deep and 37½in. high. Limited quantity at £8/15/- each, carriage 12/6.

E.H.T. GENERATOR



This is a made-up unit, power consumption (6.3 volt 8 amp. filament and approx. 50 mA H.T.). Contains three EY51 valves. Output from 6 kV to 9 kV rectified with normal H.T. rail input but somewhat higher outputs can be obtained with higher H.T. supply. Dimensions are 6½ × 4½ × 7in. Price 60/6, post, packing, etc., 5/-.

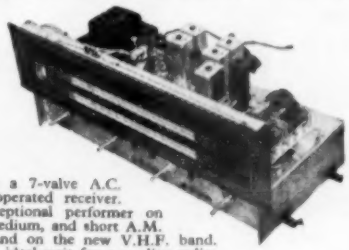
BAND III AERIALS



This is a ½ wave-length 3 element array. Of all alloy construction, the aerial is completely assembled and ready for instant mounting in loft, bedroom cupboard, window frame, etc. Price 12/6 plus 2/-.

3 element array with swan-neck mast with "U" bolt clamp for fitting to existing masts from ½in. to 2in. dia. 41/6
3 element array with cranked mast and wall mounting bracket 42/6
3 element array with cranked mast and chimney lashing equipment ... 65/-
5 element array with swan-neck mast and "U" bolt clamp for fitting existing mast from ½in. to 2in. dia. 52/6
5 element array with cranked mast and chimney lashing equipment ... 67/-
8 element array with swan-neck mast and "U" bolt clamp for fitting to ½in. to 2in. dia. mast 69/-

AM/FM RADIOGRAM CHASSIS



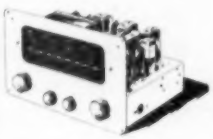
This is a 7-valve A.C. mains operated receiver. An exceptional performer on long, medium, and short A.M. bands and on the new V.H.F. band. It is an ideal unit for a quality radiogram.

Special features include magic eye tuning indicator, extra long scale and pointer travel—latest circuitry employing full A.V.C. feedback, etc., etc.

Undoubtedly one of the finest AM/FM chassis available today. Chassis size 17½in. × 6½in. × 7½in. Price £23/17/6, carriage, packing, and insurance 20/- extra.

THE ARGONAUT

The Argonaut, a very efficient medium wave and V.H.F. A.C. operated receiver described in the March and April issues of "Radio Constructor," all parts are available and total cost is only £14/10/- which includes drilled metal chassis, nine valves—one of which is a magic eye tuner of the latest type, every resistor and condenser, and even nuts and bolts, etc., needed to completely build the receiver. A cabinet will be available later in the year. The speaker not included in the above is available if required. All parts available separately, send for shopping list.

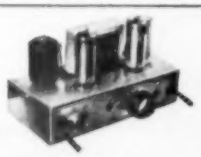


THIS MONTH'S SNIP

14in. T.V. cabinet of the latest styling made for one of our most famous firms—beautifully veneered and polished—limited quantity—19/6 each. Carriage and packing 3/6 extra.

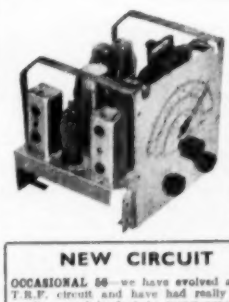
The "ESTRONIC" BAND III CONVERTER

To-day's best value in Band III converters suitable for your T.V. or money refunded. Complete ready to operate, 59/6 post mains or 85/- mains, post and insurance, 3/6.



HALF-PRICE OFFER

BEETHOVEN CHASSIS



Extremely well built on chassis size approx. 9½ × 7½ × 8½, using only first-class components, fully aligned and tested, 110-240 volt A.C. mains operation. Three wave bands covering medium and two shorts. Complete with five valves, frequency changer, double diode triode, pentode output and full wave rectifier. Special cash-with-order price this month, £5/19/6, carriage and insurance 7/6.

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PLEASE INCLUDE POSTAGE WHEN ORDERING

R1155 YOURS FOR £3

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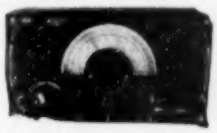

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R-1132A/R-1481	R.T.18
R-1147	CAY-46-AAM-RADAR
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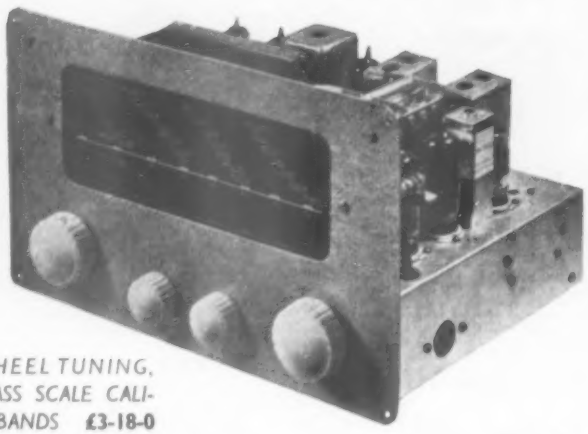

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GRUNDIG 'SPECIALIST'

Mains voltage: suitable for A.C. only, 105 – 115, 190 – 210, 210 – 230, 230 – 250 volts, 50 cycles. Power Consumption: approximately 90 watts maximum. Mains Fuses: 2 amps (for 105 – 115 volts), 1 amp (for 190 – 250 volts). H.T. fuses: 500 m/A Surge Resisting, 120 m/A Surge Resisting. Valve line-up EF 86, ECC 81, EL 84, EL 42, EM 71 + 2 metal rectifiers. Mains tapping panel and fuses instantaneously available. Two tape speeds – 3¾ ins/sec and 7½ ins/sec: speed change instantaneous by electrical means – heavy duty dual speed split phase induction motor: recording time (with 1,200 feet recording tape) 2 × 30 minutes at 7½ ins/sec – 2 × 60 minutes at 3¾ ins/sec: half track recording, track change without spool reversal: track changeover by press button approximately 2 seconds. Trackbutton remains down to indicate which track was played last: frequency range 50 – 9,000 cycles at 3¾ ins/sec, 40 – 14,000 at 7½ ins/sec: noise is down at least 40 dBs and wow and flutter less than 0.3% at 7½ ins/sec, less than 0.5% at 3¾ ins/sec.

Automatic stop foil at end of spools: fast forward and fast rewind time approximately two minutes per full spool. Illuminated precision place indicator: recording level meter by 'magic eye', tone control for treble or bass emphasis.

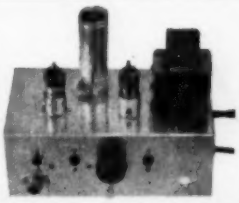
Loudspeakers: elliptical high-flux permanent magnet moving coil + two 2½ inch tweeters. Special four-position speaker control. Connections for low impedance extension speaker and high impedance external amplifier remote controls, earphones. Microphone, diode and radio input sockets.

Overall dimensions: 17 inches × 17½ inches × 9½ inches. Weight approximately 48 lb.

Retail Price **98 gns.**

BAND 3 T.V. CONVERTOR 186/196 Mc/s

("W. World," May 1954).



Kit of parts complete to build this most successful unit comprising drilled chassis 7 × 4 × 2½in., valves, wound coils, res., cond., etc.; slightly modified version using 6D3 or Z 77 instead of EF 80 valves, £2/5/- post free. Send for blue print and wiring diagram, 1/6 post free. Power Pack Components, including mains transf. and met. rect., 30/- extra. Provision has been allowed on chassis for Band 1-Band 3 switching. Kit of switch parts 7/6.

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Chassis size 13½in. × 5½in. × 2½in. Attractive Glass Dial 10in. × 4½in. edge lit by 2 pilot lamps. Horizontal or Vertical Station Names and 4 control knobs, walnut or ivory to choice. 4 position W/C switch, L.M.S. and Gram. P.U. sockets. Modern circuitry, all coils adjustable dust cored and only quality components used throughout. Delayed A.V.C. and neg. feed-back. A.C. mains 200/250 v. Double wound transf. isolates chassis from mains. Aligned and calibrated ready for use.

BRAND NEW & GUARANTEED £9.15.0 Carr. and ins. 4/6

3-ohm speakers suitable for this chassis available 8" 19/6, 10" 25/-.

This chassis is a genuine bargain and delivery is reasonably good.

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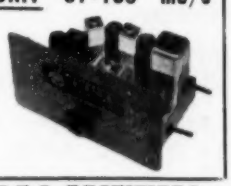
JASON F.M. TUNER UNIT 87-105 mc/s



Kit of parts to build this modern and highly successful unit complete with drilled chassis and J.B. dial, wound emitx and screening cans, 4BVA miniature valves, and all necessary quality components, etc., for only £6.10/- post free. Superior dial calibrated metres, edge lit by 2 pilot lamps, 12/6 extra. Power Pack components kit, including double wound mains transformer £2/5/- extra.

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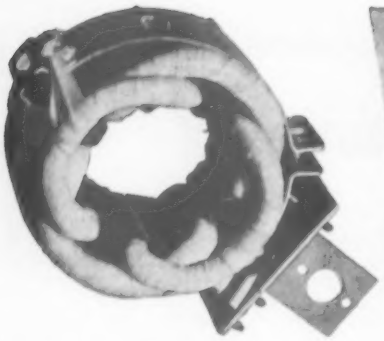

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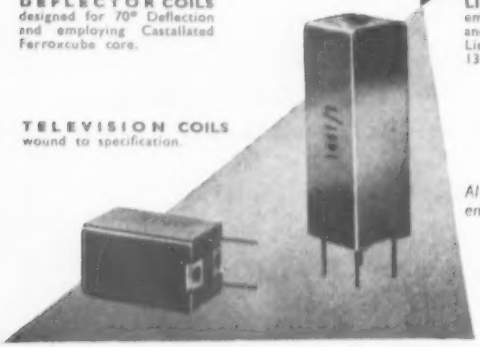

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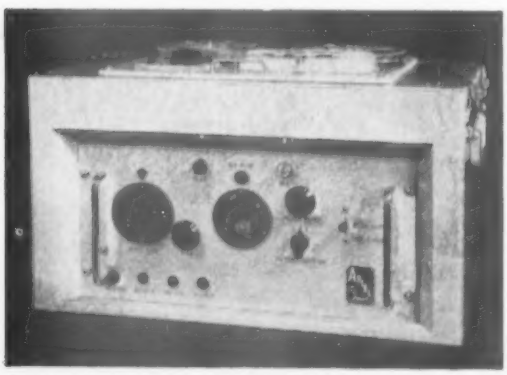

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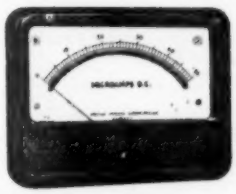

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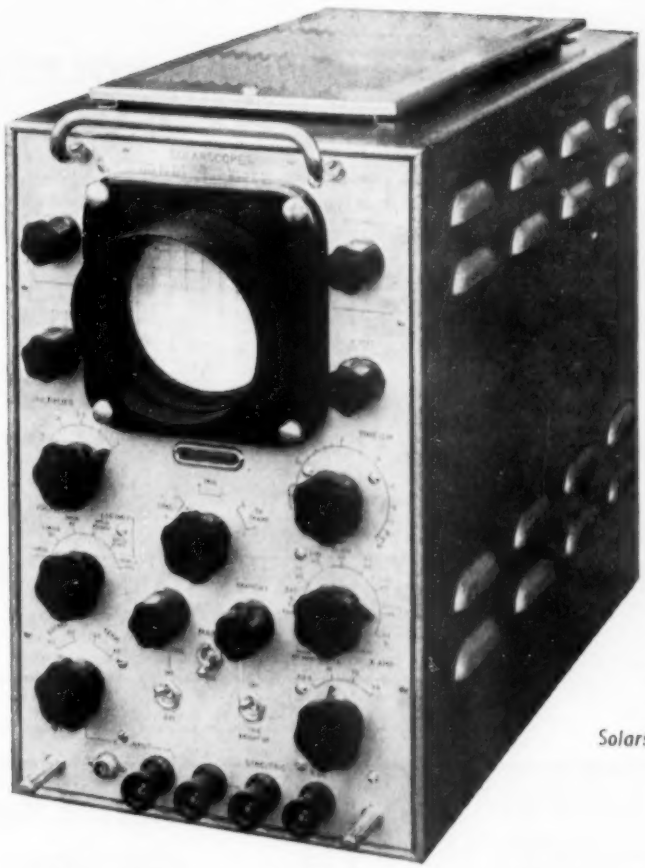

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An Outstanding Oscilloscope

A general-purpose D.C./A.C. Oscilloscope with facilities for direct time and voltage measurement on both continuous wave and pulse phenomena.

Max. Bandwidth :	D.C. to 10 Mc/s.
Sensitivity :	1 mV/cm. to 10 V/cm.
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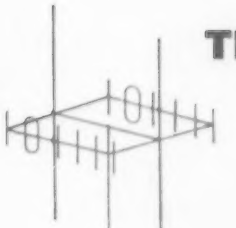

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Attenuation db/100 ft.	ET5M	ET6M	ET7M	ET8M	ET10M
10 Mc/s.	1.3	1.5	1.0	1.1	0.6
50 ,,	3.0	3.4	2.3	2.6	1.5
100 ,,	4.3	4.8	3.2	3.6	2.2
200 ,,	6.3	7.2	4.9	5.3	3.3

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Centre Conductor	1/0.022	7/0.0076	1/0.029	7/0.010	1/0.044
Over Cellular TELCOTHENE	0.093	0.093	0.128	0.128	0.200
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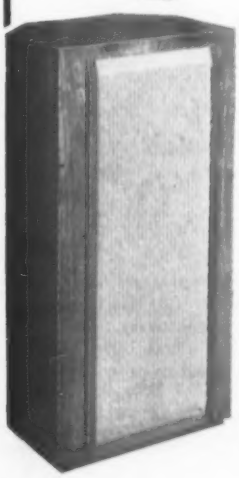

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dynamic microphone

designed to provide better tape-recordings

This new Lustraphone microphone has been produced in answer to the very real need for an instrument which is both better in performance and more dependable than types hitherto available to the many users of tape-recorders.

The "Lustrette" is of compact and elegant appearance, and can be used equally as a standing instrument or held in the hand. It embodies the very latest techniques in microphone manufacture and is fully up to professional standards. Behind the "Lustrette" microphone is a tradition of years of specialisation in microphone manufacture and design, by a firm whose microphones are used for recording, broadcasting and wherever quality instruments are sought. The "Lustrette" connects straight into existing tape-recorders to give you high standards of recording and years of trouble-free service.

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- *New design omni-directional insert.*
- *Brilliant reproduction of speech and music.*
- *Faithful to the original sound.*
- *Unobtrusive in use.*
- *For use either as stand or hand model.*
- *Carries LUSTRAPHONE STANDARD GUARANTEE*
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MODEL LD/6I—20 ohms; **LD/6IM**—200-600 ohms; **LD/6I/Z**—high impedance; **LD/6IZC**—replacement for Condenser Type. *Response substantially flat from 70—12,000 c/s. Size 2½" high × 2¼", cream ivory plastic housing. For use as stand or hand model. Supplied with 9ft. of cable.*

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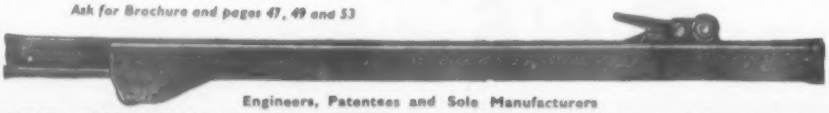

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"R.F. 26" F.M. CONVERTOR UNIT—88/100 Mc/s.

We can now offer this self contained Unit comprising 6 Valves—2-6BA6, EB91, VR137, EF54, EF54. Two I.F. stages and separate local oscillator also Muirhead graduated vernier drive assuring easy tuning.

COMPONENTS OFFERED TO COMPLETE F.M. UNIT

- New RF26 Unit with 3 valves VR137, EF54, EF54. £1/12/-.
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- Instruction Book with technical circuit and complete lay-out diagrams, 1/6.
- Voltage required 250 v. 50 mA 6.3 2 amps.
- **Special offer of all above items and RF26, including circuit, £6/5/-,** postage 3/-.

ALL ITEMS SOLD SEPARATELY.

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Unit contains VCR517 Cathode Ray 6in. tube, complete with Mu-Metal screen, 2 EF50, 4SP61, and 1 5U4G valves, 9 wire-wound volume controls and quantity of resistors and condensers. Offered BRAND NEW (less relay) at 67/6. Plus 7/6 carr. "Radio-Constructor" 'scope circuit included.

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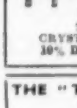

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This converter which is built around two valves type EF80 (Z719) is for use with T.R.F. or Superhet Band I Television receivers. Complete set of Teletron coils only, with practical and theoretical wiring diagram 15/- post free. Chassis measuring 7in. × 3in. × 1¼in., ready drilled to specification, 3/9 plus 9d. packing and post. Alternatively construction details only with separate individually priced parts list, 6d. post paid. The complete kit as specified, including all the above valves, etc., down to the last nut and bolt, can be supplied at 48/6 only, plus 2/- packing and post. Built up and tested 65/6. Power Pack Kit 22/6 extra.

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Ideal for Tape Recording, Gramophone Amplifier, etc. Very sensitive Guaranteed and Tested, 5/- (exmike), or 6/6 Brand new and boxed.

Acknowledged for Perfection

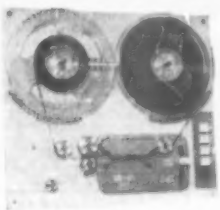
Stern's "fidelity" Tape Recorder

SUPPLIED ASSEMBLED and READY FOR USE for £43/-/-

GUARANTEED FOR 12 MONTHS (B.V.A. VALVES 90 DAYS) (Plus £1/10/- carriage and insurance. £1 is refunded when packing case is returned to us.) H.P. terms. Deposit £21/10/0 and 12 monthly payments of £1/19/11. **The items illustrated and described form the complete equipment.**

THIS RECORDER IS AVAILABLE TO MAIL ORDER CUSTOMERS.
SEND S.A.E. FOR ILLUSTRATED AND DESCRIPTIVE LEAFLET.

- **Will play the new pre-recorded tapes.**
- **Provides 2 hours playing time at 3¾in. or 1 hour at 7½in. per second.**
- **Will take all standard reels up to 1,200 ft.**
- **Extension speaker sockets are provided.**
- **Has dual input channels for "mixing".**



THE NEW TRUVOX MODEL TR7U TAPE DECK

THE NEW TRUVOX MODEL TR7U TAPE DECK. 3 Shaded-Pole motors. Drop-in Tape Loading. Push Button Control. Separate Push Button Brake. Fast forward and fast reverse. Silent drive eliminating Wow and Flutter. Half Track working and 2 speeds, 3¾in. and 7½in. per sec. Positive Azimuth Adjustment. Overall size only 14½ x 12½in.

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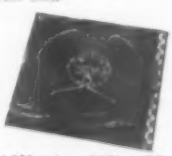
This amplifier has been expressly designed to meet the requirements of enthusiasts for fidelity reproduction, and in particular to CORRECTLY operate the above TRUVOX DECK. It is supplied complete with a matched Elliptical 3 ohm P.M. Speaker, it incorporates an efficient Tone Control arrangement and has a Magic Eye Level Indicator (Operative on Record). A Co-axial socket is also incorporated for MONITORING on Record. This can also be used to feed an external amplifier. The Amplifier can also be used for high quality reproduction of gramophone records direct from a gram unit.

ACOS CRYSTAL MICROPHONE MODEL MIC.33.1



1,200 ft. REEL OF SCOTCHBOY MAGNETIC RECORDING TAPE.

PORTABLE ATTACHE CASE

This, as may be judged from the illustration above, is a neat, compact and attractively finished case, being covered with maroon rexine and having an ivory coloured speaker escutcheon. It contains concealed pockets to accommodate the Microphone, Mains Lead and a spare 1,200ft. reel of tape.

HOME CONSTRUCTORS!!

BUILD IT FOR £40/-/-

IT ONLY NEEDS CONNECTING UP

H.P. Terms are shown below.

The actual assembly of the Tape Recorder is extremely simple and only involves a few connections. The Truvox Tape Deck and the Quality Amplifier are supplied tested and ready for use, and all that is required to complete the Recorder is to connect the two together (a connection chart is supplied for this purpose) and secure them by the screws provided into the Attache Case.

PRICE SUMMARY

WE WILL SUPPLY ALL FIVE UNITS LISTED ABOVE, i.e. THE COMPLETE BUT UNASSEMBLED RECORDER FOR £40. H.P. Terms: Deposit £10 and 12 monthly payments of £2/15/- or in two parts as follows:—

	CASH PRICE	DEPOSIT	12 monthly payments of
(a) TRUVOX Mk. TR7U TAPE DECK MODEL TRIF AMPLIFIER WITH SPEAKER, 1,200ft. REEL OF TAPE	£33 10 0	£16 15 0	£1 11 1
(b) ATTACHE CASE AS ILLUSTRATED, ACOS CRYSTAL MICROPHONE	£6 10 0	—	—

See note below re packing charge

NOTE: Please send 30/- to cover cost of packing, carriage and insurance. We will refund £1 if the packing case is returned to us intact.

EACH UNIT IS AVAILABLE SEPARATELY AS FOLLOWS:

	CASH PRICE	DEPOSIT	12 monthly payments of
(a) TRUVOX Mk. TR7U TAPE DECK	£23 2 0	£11 11 0	£1 1 5
(b) AMPLIFIER MODEL TRIF WITH SPEAKER	£14 14 0	£7 7 0	& 9 months at 18/6
(c) PORTABLE ATTACHE CASE	£5 0 0	—	—
(d) ACOS CRYSTAL MIKE "33"	£2 10 0	—	—
(e) REEL OF TAPE 1,200ft.	£1 15 0	—	—

Please include £1 when ordering (a) or (c) for packing charge, this whole amount will be refunded if case is returned to us intact.

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				9001	5/6	ECC84	12/6	PY82	10/6
				9003	5/6	ECH35	13/6	QP21	7/6
				9004	5/6	ECH42	10/6	SP22	6/-
				9006	6/-	ECH81	13/6	SP220	6/9
				954	2/-	ECL80	10/6	U22	8/-
				955	4/9	EF22	8/6	U329	13/6
				956	3/6	EF41	11/6	U403	10/-
				10C2	12/6	EF42	13/6	U404	9/-
				10F1	12/6	EF80	10/-	UB41	8/-
				10F9	12/6	EF86	10/6	UBC41	11/-
				10P13	11/6	EL2	12/6	UCH42	11/-
				12A6	6/9	EL41	11/6	UF41	11/6
				12AH7	6/9	EL84	12/-	UL41	11/6
				12AT7	9/-	EM34	11/6	UY41	10/6
				12AU7	9/6	EM80	12/6	VR21	3/-
				12BA6	10/-	EY51	13/6	VR53	6/6
				12BE6	10/-	EZ40	10/-	VR54	2/-
				12C8	8/-	EZ41	11/-	VR55	7/6
				12H6	5/-	EZ80	12/6	VR56	6/-
				12J5	6/-	E1148	2/-	VR57	8/-
				12J7	9/6	EY91	7/-	VR65	3/6
				12K7	9/6	FW4/500	10/-	VR65A	3/3
				12K8	11/-	GZ32	12/6	VR66	3/9
0Z4	6/-	6F6M	8/6	12Q7	9/6	H30	5/-	VR91	5/6
1A3	6/-	6F11	13/-	12SC7	7/6	HL2	8/6	VR91SYL	7/6
1A5GT	6/6	6F13	13/6	12SG7	7/6	HL23DD	7/6	VR92	2/-
1A7	11/6	6F15	13/6	12SH7	5/6	HP211C	6/9	VR105/30	7/6
1C5GT	8/9	6G6G	4/-	12SJ7	8/6	KL35	8/6	VR116	4/-
1H5GT	10/6	6H6	3/6	12SK7	6/6	KT2	5/-	VR119	4/-
1N5GT	10/6	6J5/GT	5/-	12SQ7	8/6	KT33C	10/6	VR136	7/-
1L4	6/6	6J5M	6/6	12SR7	7/6	KT66	10/6	VR137	5/6
1LD5	6/9	6J6	7/6	20D1	10/6	KTW61	7/9	VR150/30	8/-
1R5	8/-	6J7G	6/6	20L1	12/6	KTW63	8/6	VP23	8/-
1S5	7/6	6K6GT	6/6	25L6GT	8/6	KTZ41	6/-	V570	3/-
1T4	7/6	6K7G/GT		25U4GT	10/-	LP220	6/9	VT52	8/-
1U5	8/-		5/9	25Y5G	11/6	M4/4	5/6	VT501	6/-
2X2	4/-	6K7	6/9	25Z4G	9/-	MS/PEN	5/-	VU39	8/9
3A4	7/-	6K8G	8/9	25Z6GT	8/6	N78	12/6	VU64	6/-
3Q4	9/6	6K8GT	9/6	35L6GT	9/-	N709	12/-	VU111	8/6
3Q5	10/-	6L1	13/6	35W4	10/-	P41	9/-	VU120A	3/-
3D6	5/6	6L6G	9/-	35Z4GT	9/-	P215	5/-	W77	8/6
3S4	8/6	6L7M	7/6	50L6GT	9/-	PEN25	8/-	W61	8/-
3V4	8/6	6N7	7/-	AC/P	6/9	PEN46	8/6	X65	10/-
4D1	3/-	6Q7G/GT		AC6/PEN	6/6	PEN220A	4/-	X66	11/6
42	8/-		9/-	ATP4	6/6	PCC84	13/6	Y63	9/-
5U4G	8/6	6SA7GT	8/-	AZ1	10/6	PCF80	13/6	150A(B)	4/6
5Y3GT	8/6	6S7	7/6	DH73M	9/-	PCF82	12/6	12SC7	7/6
5Z3	8/6	6SH7	6/-	EABC80	13/6	PCL83	13/6	AZ31	10/6
5Z4G	8/9	6SJ7GT	8/-	EAC91	10/-	PL81	13/6	5R4GY	9/6
6A7	10/6	6SK7	5/6	EAF42	12/6	PL82	11/6		
6A8G/GT		6SL7	8/-						
	10/6	6SN7	8/-						
6AC7	6/6	6SQ7	9/3						
6AG5	6/6	6S57	8/-						
6AK5	6/6	6U4GT	15/-						
6AL5	7/-	6U5G	8/6						
6AM5	5/-	6U7G	9/-						
6AM6	7/6	6V6G/GT							
6AQ5	9/-		7/6						
6AT6	8/9	6X4	8/-						
6B4	5/-	6X5GT	7/9						
6B8	4/-	7B6	9/6						
6BA6	8/-	7B7	9/-						
6BE6	8/-	7C5	8/6						
6BW6	9/-	7C6	9/-						
6C4	7/-	7H7	8/-						
6C5GT	7/6	7Q7	8/-						
6C6	6/6	7R7	8/6						
6C9	10/-	7S7	9/-						
6D3	7/6	7Y4	8/6						
6D6	7/3	75	10/6						
6F6G	7/6	77	8/-						

YAXLEY TYPE SWITCHES

	each
1 Pole, 4-Way	1/6
2 Pole, change-over	1/3
3 Pole, 3 Bank, 3-Way	1/6
4 Pole, 2-Way	1/9
2 Pole, 3-Way with Black Knob	1/6
5-Way, 2 Pole, 3 Bank	2/-

VOLUME CONTROLS, ETC.

	each
Miniature Volume Controls, double pole switch, 2 Meg. r.	4/6
Standard Controls, single pole switch, 2 Meg. r. and ½ Meg. r.	3/6

VALVEHOLDERS

B7G, B9A, B9G, etc., Moulded Types	9d.
B7G with Screening Cans	1/6
Ceramic international Octal	1/-
Duodecal Paxolin	9d.

CABLES, ETC.

	yard
Twin Flat Transparent Mains Flex 14/0076	3d.
Screened Cable Singles	6d.
Twin	7d.
Push Back Wire, 14 Strands	2d.
Semi Air Spaced Co-axial Cable	9d.
Solid 1/0022	7d.
Stranded 7/0076	8d.

★ ★ ★ ★ ★ ★ ★

Build this Excellent Kit for Yourself!

ALPHA 3 VALVE T.R.F. KIT

£5 . 10 . 0

★ Easy to Build.
★ Valves 6J7, 6K7, 6V6GT plus metal rectifier.
★ Walnut cabinet.

Full instructions, point to point wiring diagram. Circuit diagram, and full shopping list 1/-. All components may be purchased separately.

MAINS DROPPING RESISTANCES

	each
725 ohms Erie tap at 600 ohms	1/6
650 ohms taps at 375 ohms, 500 ohms, 5 ohms, 30 ohms	2/6
770 ohms Mains Dropper for Midget Radios with a tap at 125 ohms, size 3in. long x ¾in. dia.	1/3
Dagole Mains Dropper .3A, cement coated with 2 sliders .2 amp. as above, 1,200 ohms	3/9
Green Vitreous Mains Dropper, 1,328 ohms, 2 taps	1/3
Zenith Mains Dropper, 910 ohms	2/-

C.R.T. ISOLATION TRANSFORMERS Type NR9

Ratio 1-1.25 giving a 25% boost on secondary. Particularly suitable for High Definition Receivers. Four types available to cover most tube heaters.
NR 9A 2 volt; NR 9B, 4 volt; NR 9C, 6.3 volt; NR 9D, 10.8 volt; NR 9E, 13.3 volt.
With Tag Panel and Solder Tags, **10/6** each.

Type NR12

Mains input: 220/240 volts.
Multi output: 0-2-4-6.3-7.3-10 and 13 volts.
Input has two taps which increase output volts by 25% and 50% respectively.
This transformer is suitable for most Cathode Ray Tubes in Medium Definition Receivers.
The MOST versatile Low Capacity C.R. Transformer with Universal Output.
With Tag Panel and Solder Tags, **21/-** each.

Type NR14

A most useful transformer for use with 2 volt Tubes with falling emission.
Input: 230/240 volts.
Output: 2-2½-2½-2½-3 volts at 2 amps.
With Tag Panel and Solder Tags, **17/6** each.

★ ★ ★ ★ ★ ★ ★

SPECIAL PURCHASE!

G.E.C. Cabinet Loudspeakers, Cat. No. BC1955, 6in. P.M. Moving Coil Loudspeaker Unit, 2/4 ohms, with Volume Control. Price **60/-** each.

★ ★ ★ ★ ★ ★ ★

PHIPCO ALL-IN-ONE RADIO METER

Tests L.T. 0-6 v. A.C./D.C., H.T. 0-240 v., A.C./D.C., M/A 0-30. Black Bakelite Case. Internal Battery for Circuit Testing. Price **32/6** each.

VARIABLE CONDENSERS

	each
3 gang .0005 mfd.	5/9
2 gang .00035 mfd.	5/9
2 gang .0005 mfd. with feet and trimmers	7/6
2 gang Midget with dust cover .00035 mfd. with trimmers	8/6
2 gang Midget .0005 mfd.	7/6

T.S.L. FERRO-MAGNETIC AERIAL ROD

A length of Ferrite rod with full instructions for winding Medium or Medium and Long Wave internal aerials. **6/-** each.

STC RECTIFIERS

RM 1	3/10	RM 3	5/-
RM 2	4/3	RM 4	10/-

SMALL SUB-CHASSIS

	each
With 2 valveholders for 954, 955 type of valves	5/-

PENCIL RECTIFIERS

K 3/25	5/8	K 3/50	8/8
K 3/40	7/6	K 3/60	9/8
K 3/45	8/2	K 3/100	14/8

HEATER TRANSFORMERS Primary 230 v.

Available:

	each
2 volt ½ amp.	4/6
4 volt 1.5 amp.	5/-
5 volt 2 amp.	10/-
6.3 volt 1½ amp.	6/-
2 volt 3 amp.	7/9
4 volt 3 amp.	10/-
6.3 volt ½ amp.	5/-
6.3 volt 3 amp.	9/6
12 volt .75 amp.	5/-

LOUDSPEAKER CABINETS

This attractive walnut finished cabinet is available for 6½in. or 8in. speaker units. Metal speaker fret, complete with back and rubber feet.
6½in. type:
Measures 8½in. x 8½in. x 4½in. at base. Price **16/6** each.
8in. type:
Measures 10½in. x 10½in. x 5in. at base. Price **20/6** each.
5in. type:
Measures 6½in. x 4½in. x 7½in. **16/6**

LOUDSPEAKER UNITS, ETC.

	each
5in. Types by Elac., Lectrona, Celestian, etc.	17/6
6½in. Types by Goodmans, Rola, R. & A.	18/6
8in. Types by Goodmans, Plessey, R. & A.	19/6
10in. Types by R. & A. Celestian, etc.	25/6
6½in. Wafer Speaker by Truvox, suitable for Car Radio, etc.	20/-
12in. Plessey Lightweight Elliptical Speakers, Goodmans 4in. x 7 in.	25/- 19/6

All above are P.M. Speakers. Standard 2-4 v. Speech Coil.

TELEVISION TABLE

Size of top, 19½in. x 19½in. Height, 18in. Rounded legs which unscrew for transit. **40/-** each, carriage 3/-.

CONNECTOR LEADS

Red single lead with wander plug and socket. **4d.** each.

WHEN ORDERING PLEASE QUOTE "DEPT. W.W."

ALPHA RADIO SUPPLY CO.

5/6 VINCES CHAMBERS VICTORIA SQUARE LEEDS 1.

TERMS: Cash with order or C.O.D. Postage and Packing charges extra, as follows: Orders value 10/- add 9d.; 20/- add 1/-; 40/- add 1/6; £5 add 2/-; unless otherwise stated. Minimum C.O.D. fee and postage 2/3.

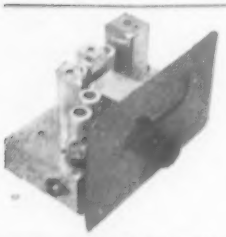
MAIL ORDER ONLY

CLYNE RADIO LTD.

18, TOTTENHAM COURT ROAD, LONDON, W.1.

MUSeum 5929/0095.
(50 yards only from Tottenham Court Road Tube !)
All post orders please to:—24-26, HAMPSTEAD RD., LONDON, N.W.1
EUSton 5533/4/5

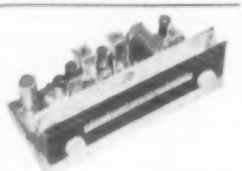
TELETRON BAND III CONVERTOR! Still available, this very popular convertor kit as illustrated and fully described in previous issues of the "W.W." For use with most T.R.F. or Superhet Band I T.V. Receivers. Construction details only, with separate individually priced parts list 6d. post free. Kit complete as specified 48/6, plus 2/- p. and p.
Mk. II Fringe area version kit complete 59/6, plus 2/- p. and p. Power pack kit for either of above 25/-.
We carry comprehensive stocks of all Band III Convertors by leading manufacturers. Also aerials, cross-over boxes, air-spaced/low-loss co-axial cable at 10d. per yard. Let us have your enquiries. Any branded convertor supplied on H.P. terms!



THE JASON F.M. TUNER

Based on the booklet by Data Publications Ltd., 2/- post free, including our individually priced Parts List. Highly sensitive, free from drift. Incorporates 4 valves 6AM6 and 2 specially graded G.E.C. Crystals. The kit supplied includes drilled chassis with tuning condenser, scale calibrated in mc/s., and attractive bronze stove-enamelled front plate already mounted (illustrated). Front plate size 8in. × 5in., chassis 7in. × 4¼in. × 1¼in. Complete standard kit **£6/15/-** plus 2/6 p. and p. Fringe area kit **£7/15/-**, plus p. and p.

THE T.S.L F.M. TUNER!



We can now supply this FM/VHF adaptor either in kit form, or fully assembled, wired and tested. Our price for the ready-built unit which incorporates its own power supply, is **£13/15/-** only tax paid, plus 5/- P. &P. or H.P. terms. Or the kit complete as specified **£10/19/6** plus 3/6 P. & P. The booklet "F.M. TUNER CONSTRUCTION" (23 pages) with full technical data and point-to-point wiring diagrams, together with our separately priced parts list, is available at **2/6** post free.

THE GRADIENT F.M. TUNER FMT4. We are still able to offer our latest F.M. TUNER as illustrated and described in our previous advertisements. Illustrated comprehensive instruction booklet with individually priced component list 1/6 post free. Or, the kit complete right down to the last nut and bolt **£8/19/6**, plus 2/6 P. & P.

THE T.S.L. AM/FM CHASSIS! Exceptional value. Covers L, M, and S.W. plus F.M.! 8-valve push-pull output. Ferrite rod aerial. Valve line-up: ECC85, ECH81, EF89, EABC80, ECC82, two 6BW6s plus 5y3. Large full-vision dial, size 14½ × 6in. Chassis size, overall: 15 × 7¼ × 8in. high. Tax paid 26 guineas, plus 5/- packing and carriage. A supplementary extra is magic eye EM34, complete with escutcheon and fixing cable at **26/-**. H.P. terms available. Demonstrations at 18 Tottenham Court Road!

THE DULCI F.M. TUNER. Incorporates own power supply, suitable for use with any amplifier. Valve line-up: ECC85, two EF89, EABC80, 6x4, and EM80 indicator! Overall size: 9 × 6 × 5½in. high. Pre-Budget price **£16/16/-** plus 5/- P. & P. Illustrated leaflet available, also H.P. terms.

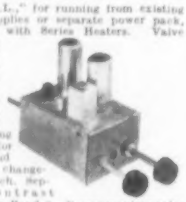
SPECIAL OFFER!! Champion Model 855 FM/VHF Adaptor! Designed for the instant conversion of A.C. radiograms, table A.M. receivers and Hi-Fi audio amplifiers, to enable owners through their existing equipment to obtain the best results from the new F.M. transmissions. Two connections only. One to the A.C. mains supply, the other to the pick-up sockets. Valve line-up: EF85, two EF80s, EB91, and EZ80. In attractive red and cream bakelite cabinet. Illustrated leaflet available on request. Price whilst stocks last only **£13/19/6** tax paid, plus 3/6 P. & P. H.P. terms available.

DENCO F.M. TUNER. This highly successful kit is still available at inclusive price of **£6/7/6** plus 2/6 P. & P. This kit includes all components and the five valves required for the extra I.F. Stage for fringe area reception. If required, "Denco" dial and drive assembly is available for the above at 9/- extra. Full constructional details **1/6** post free.

F.M. POWER PACK KIT. We can now supply complete kit for power pack suitable for the above F.M. tuners or any other similar type. Price for the complete kit is **37/6** only, or **52/6** for ready assembled unit. This pack is extremely small, incorporating valve rectifier type 6X4 and built on chassis size only 6 × 4 × 1¼in. Optional extra for power pack, Bulgin Octal Plug **2/3**.

COMPETITIVE !! BAND III CONVERTORS!

Type "E6," with self-contained power pack and change-over switch for Band 1/3. Valve line-up 2-EF80. Size 4in. × 4¼in. × 3¼in. 8-segment contrast control for Band 3, very simple to tune. Complete with 6in. coaxial output lead. 200 / 250 volts A.C. only. Price **£6/7/6**. P.&P. 2/6



Type "M.L." for running from existing power supplies or separate power pack. Available with Series Heaters. Valve line-up: PCC84 and PCF80. Size 4 × 2½ × 4¼in. Fitted with external fine tuning control for Band 3 and Band 1/3 change-over switch. Separate contrast control for Band 3. Power requirements H.T. 150/250 v. at 30 mA., L.T. 15/16 v. 3 amp. (Series Heaters). Unit simply fitted inside cabinet. Complete with handsome escutcheon. Price **£4/12/6**. P. & P. 2/6. Full instructions supplied with each unit. Please specify whether required for London or Birmingham.

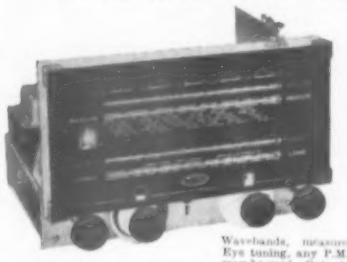
TWO NEW CONVERTORS!

THE FAMOUS UNIVERTER—COMPARE THE PRICE!

Handsome walnut cabinet. Suitable all areas. Contains own power supply. Simply connect to aerial. Four-valve circuit. Complete with all instructions **£6/19/6** plus 3/6 P. & P.

A.M/F.M.!

INTRODUCING DULCI RADIO/RADIOGRAM CHASSIS TYPE H4!

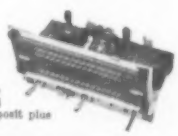


Incorporating the normal Long, Medium and Short wave bands, plus V.H.F. (Frequency Modulated) 87-101 mc/s. Latest miniature B.V.A. valves ECC85, ECH81, EF89, EABC80, EL84, EZ80, EM80. High Q inductances used throughout—Ferrite rods, for Medium and Long Waves. Overall dimensions: Length 12in., Depth, including knobs and spindles, 9¾in. Height 7¾in. Dial, which is multi-coloured on black background, has indicators for tone control and Wavebands, measures 11¼in. × 5¼in. Magic Eye tuning, any P.M. speaker of 3 or 15 ohms may be used. Output 4 watts. Price is **£27/16/-** tax paid or H.P. terms. Packing and carriage charge 5/-. Illustrated leaflet available on request.

AM/FM KIT! FIRST AGAIN!

Introducing the **JASON AM/FM KIT** for medium waves and F.M.! By the time this advertisement appears we hope to have full details available. As illustrated this is a very high quality chassis incorporating 8 of the latest miniature valves, plus DM70 magic eye. Kits will be available for chassis complete with output stage at **£15/5/-**. Also less output stage but with own built-in power pack at **£13/19/6** only. These are high fidelity units and exceptional value at these prices which include all required components and full constructional details. Individually priced component list available on request. Both plus 3/6 P. & P.

SPECIAL PURCHASE! MANUFACTURER'S SURPLUS



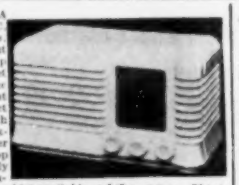
Owing to favourable purchase, we can offer strictly limited quantity of these handsome chassis. AC/DC 200/250 v. for Medium and Long Waves, plus gram position. Incorporates own frame aerial. Valve line-up: U107, N108, DH107, W107 and X109. Overall chassis size 12 × 5½ × 7¼in. high. Attractive bronze dial with orange and cream lettering. Dial size 11½ × 4¼in. Scale length 7¼in. Logging scale provided. Price **£7/19/6** only tax paid, plus 3/6 P. & P. H.P. terms. £4 deposit plus four monthly payments of **22/-**.

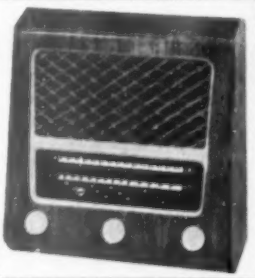
THE R.C. GRAM REPLACEMENT CHASSIS KIT

To meet the very great demand for this type of receiver, we have produced this unit! For Long, Medium and Short Waves. Valve line-up: 6K8 Frequency changer, 6K7, I.F. Amplifier, 6Q7 1st Audio Detector and A.V.C. 6V6 Output, 6X5 Full-wave rectifier. For A.C. mains 200/250 volts. 4 watts output. Excellent quality. High sensitivity. Provision for gram. Attractive illuminated black, red, green and gold dial for horizontal tuning. Four controls are: Tuning, L/M/S Gram. Vol./on/off. Tone (variable). Chassis size: 13½ × 5½ × 2½in. Dial size: 10 × 4½in. Assembly is simplified by the use of a 3-waveband coil pack, and pre-aligned 465 Kc/s. I.F. transformers—high-grade drop-through half-shrouded Mains Transformer, with voltage adjuster panel. This chassis can easily be assembled in one evening. Illustrated pamphlet with full assembly instructions, practical and theoretical wiring diagrams and itemised price list **1/6** post free. The main items for this receiver can be supplied separately, as under. Drilled chassis, complete with valve-holders, A/E panel, P/U panel, tuning, condenser and ready-assembled dial and drive at **39/6**. 3-waveband coil pack with gram position **39/6** tax paid. Pair of 465 Kc/s. I.F. Transformers **9/6** pair. Half shrouded drop-through Mains Transformer **22/6**. The total cost of ALL items purchased separately is nearly £10 but we shall be pleased to supply all the required components right down to the last nut and bolt at a special inclusive price of **£8/8/-** plus 2/6 packing and postage. A set of four small brown and cream engraved knobs to suit is available at 1/2 each knob. This chassis is a professional job in every respect and can be seen and heard at our premises. This chassis can also be supplied, ready assembled in very limited quantities at **£9/19/6** plus 5/- carriage and packing.

Please add postage under £1 or Cash with order. C.O.D charge extra—open 9 a.m. to 6 p.m. Monday to Friday. Sorry but we close at 1 p.m. on Saturday.

THE "ECONOMY FOUR" T.R.F. KIT. A three-valve plus metal-rectifier receiver, A.C. mains 200/250 v. Medium and Long waves. We can supply all required components right down to the last nut and bolt. Valve line-up 6K7, 6J7 and 6V6. Chassis ready drilled—Cabinet size 12in. long by 6in. high by 5in. deep—Choice of ivory or brown Bakelite, or wooden walnut finish cabinet. Complete instruction booklet with practical and theoretical diagrams. Each component brand new and tested prior to packing. Our price **£5/10/-** complete—Remember this set is being demonstrated at our shop premises! We proudly claim that our fully illustrated instruction booklet is the most comprehensive available for this type of receiver—Booklet available at **1/6** post free. This is allowed if kit is purchased later. Please add 2/6 packing and carriage for complete kit.





THE "SUPERIOR" FOUR KIT. Our new four-valve receiver, A.C. mains, 200/250 v. **M.** and Long waves. As with our very successful "Economy Four" all required components are supplied. Valve line-up: 2 6BH7, 6 X50T and 6 V66T. Chassis ready drilled. Cabinet size, 10½in. × 10in. wide. Maximum depth at base 5in. tapering to 3½in. at top. Sloping front. Very attractively finished in light walnut and peach. Each component brand new and tested prior to packing. Complete instruction booklet with practical and theoretical diagrams is provided. Booklet available at **1/6** post free. Our price for complete kit, **£6/9/6**! Please add 2/6 packing and carriage. If preferred, we can supply Cabinet Assembly only, comprising Cabinet and bracket wave-change switch, dial, pointer, drum pulleys, drive spindle, drive spring and knobs, at **45/-**, plus 2/6 packing and carriage. **N.B.**—Our kits are even supplied with sufficient solder for the job.

N.B. All our T.R.F. Kit circuits now include specially wound Denco "Maxi-Q" coils on polystyrene formers, improved performance! Price remains the same.

SURPLUS BARGAINS

METERS

F.S.D.	Size	Type	Fitting	Price
50 microamp	D.C. 2in.	M.C.	R.F.	50/-
50 microamp	D.C. 3½in.	M.C.	F.S. (Tropicalised)	85/-
50 microamp	D.C. 5in.	M.C.	Rectangular	120/-
50 microamp	D.C. 4in.	M.C.	Rectangular	110/-
50 microamp	D.C. 3½in.	M.C.	F.S.	95/-
100 microamp	D.C. 2½in.	M.C.	F.S.	45/-
200 microamp	D.C. 2in.	M.C.	F.S. (Tropicalised)	50/-
500 microamp	D.C. 2in.	M.C.	F.S.	18/6
1 mA.	D.C. 2in.	M.C.	F.S.	17/6
1 mA.	D.C. 2in.	M.C.	F. Sq. (1954 manufacture by Elliott)	25/-
1 mA.	D.C. 2½in.	M.C.	Desk Type	30/-
5 mA.	D.C. 2in.	M.C.	F. Sq.	10/-
50 mA.	D.C. 2in.	M.C.	F. Sq.	8/6
150 mA.	D.C. 2in.	M.C.	F. Sq.	7/6
500 mA.	D.C. 2½in.	M.C.	F.S.	10/6
.5 amp	R.F. 2in.	Thermo	F. Sq.	6/8
1 amp.	R.F. 2½in.	M.C.	F.S.	10/-
20-0-20 amp.	D.C. 2in.	M.C.	F. Sq.	7/6
120-0-120 amp.	D.C. 2in.	M.C.	F. Sq. (shunt required)	15/-
150 amp.	A.C. 4in.	M.I.	R.F.	45/-
1 amp.	R.F. 2½in.	Thermo	R.F.	7/6
3 amp.	R.F. 2½in.	Thermo	F. Sq.	6/-
5 amp.	D.C. 2in.	M.C.	F. Sq.	13/6
6 amp.	R.F. 2½in.	M.C.	Thermo F.S.	7/6
20 amp.	D.C. 2in.	—	R.F. (with shunt)	10/6
25 amp.	D.C. 2½in.	M.I.	F.S.	6/6
30 amp.	D.C. 2½in.	M.I.	F.S.	12/6
15 volt	A.C. 2½in.	M.I.	F.S.	10/-
20 volt (5 mA.)	D.C. 2in.	M.C.	F. Sq.	7/6
15-0-15 volt	D.C. 2½in.	M.C.	F.S.	17/6
300 volt	A.C. 2½in.	M.C.	F.S.	35/-
300 volt	A.C. 3½in.	M.I.	F.S.	30/-

SPECIAL. U.S. 0-1 mA. 2½in. taken from equipment but perfect, **22/6** each. R.F. = Round Projection. M.C. = Moving Coil. Thermo = Thermo-coupled. F. Sq. = Flush Square. F.S. = Flush Round. M.I. = Moving Iron.

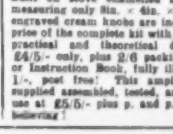
METER RECTIFIERS, 1 mA. by G.E.C., at **8/6**, also 5 mA. by G.E.C., at **8/6**.

COMMUNICATION RECEIVER PCR.2 5-wave band, 13-50, 190-570, 900-2,000 metres. Valve line-up 6V6, EBC33, X61 and 3-EF.39. Illuminated calibrated dial, flywheel tuning, aerial trimmer. In black crackle case size 17½in. × 10½in. × 8in. Output socket for 3 ohm speaker, or headphones. Absolutely brand new in original cartons, manufactured for Govt. by PYE LTD.

Price **£7/10/-** only, plus p. and p. 10/-. With each set we supply full conversion details for A.C. mains. All required components for conversion available at **32/6** post paid. Limited quantity.

We can now supply already converted ready for A.C. Mains at **£10/5/-**, plus carriage. H.P. available.

THE R.C. 3/4 WATT AMPLIFIER KIT.



Just released! Compare the advantages! Treble, bass, AND middle controls! For crystal or magnetic pickup! A.C. Mains, 200/250 v. Valve line-up, 6V6GT, 6BH7, metal 6X8GT. Negative feedback. Built on stove enamelled steel chassis, measuring only 8in. × 4in. × 1¼in. Four engraved cream knobs are included in the price of the complete kit with all necessary practical and theoretical diagrams, at £4/5/- only, plus 2/6 packing and post, or Instruction Book, fully illustrated, for 1/-, post free! This amplifier can be supplied assembled, tested, and ready for use at £5/5/- plus p. and p. Hearing is believing!

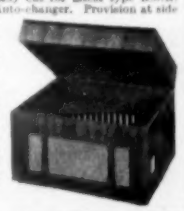
THE R.C. RAMBLER ALL-DRY PORTABLE KIT

Full assembly details with practical and theoretical diagrams can be supplied at **1/6** post free. This is a truly professional 4-valve superhet—all dry—for medium and long waves. A cream plastic top panel, with dial engraved in red and green, adds to the very imposing appearance of this model which is housed in an attractive cream and grey leatherette covered attaché-case type cabinet measuring only 9in. × 7in. × 5¼in. Weight less batteries 4¼lb., with batteries 6¼lb. This set really has everything. Built-in frame aerial, high quality, extremely sensitive, and very adequate volume from the 5in. speaker. Valve line-up 3V4, 1R5, 1S5, 1T4. Also the required components, exactly as specified, including cabinet, can be supplied from stock at the special inclusive price of **£7/7/-** plus 2/6 p. and p. (less batteries). Uses Ever-Ready 90 v. H.T. type B126 at **9/3**. Also LT. 1.5 v. A.D. 35 at **1/4**.

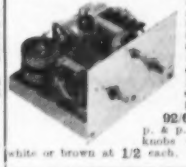
RAMBLER MAINS UNIT! At last we are able to offer our special mains units kit for using our popular all-dry "Rambler" on A.C. Mains. Complete kit, which when assembled fits neatly into battery compartment, can be supplied at 47/6, plus 1/6 packing and postage. Price includes all required components, and full assembly instructions. N.B.—This unit is completely self-contained in a metal box measuring 7in. × 3¼in. × 1¼in. and is ideally suitable for ANY all-dry battery portable requiring 90 v. H.T. and 1.5 v. L.T.

B.S.R. MONARCH. The very latest cream 3-speed mixer Auto-changer. Complete with turn-over crystal pick-up. Complete in original manufacturer's cartons, fully guaranteed. Price only **£7/19/6**. Buy now! Quantity at this price strictly limited.

TABLEGRAM CABINETS. Manufacturer's surplus! Handsome dark walnut finish. Size 16¼in. × 13½in. × 11¼in. high. Motor board already cut for latest type B.S.R. Monarch Auto-changer. Provision at side for amplifier controls. Price **79/6** plus 5/- p. & p. Baffle fitted for 7in. × 4in. elliptical speaker for which we can supply latest RODLA at **£1/6**.



PORTABLE AMPLIFIER. To meet a universal demand, we have produced a quality amplifier, primarily for use with the Vitavoice illustrated above, but equally suitable for any portable record-playing equipment. Comprising EL84 (output), EABC80 (Tripis Diode Triode) and metal rectifier (2 of RM2). For A.C. mains. Including separate treble and bass controls. Chassis measures 6in. × 8in. Front plate 6in. × 4½in. high. Price **92/6**, plus 2/6 p. & p. Engraved knobs to suit in white or brown at **1/2** each.



HIGH FIDELITY!! Introducing the T.S.L. Lorenz LP312-9 12in. bi-axial triple unit speaker. Consisting of a 12in. wide-range speaker, utilising the very latest super high flux magnet alloys, combined with two T.S.L. Lorenz LPH 65 permanent magnet moving coil electro-magnetic high frequency treble units. These latter are suitably placed on a steel bracket in the centre of the front of the main speaker so that they do not project beyond the front of the speaker mounting baffle. These two treble units are offset at a specially calculated angle to effectively give 360° spherical response. Base unit 15 ohms, treble units each 5½ ohms. Frequency range 15-22,500 cycles level response. Power rating 25 watts average, peak power rating 40 watts. Cross-over frequency for the treble units 2,000 cycles. Finished in grey and blue vitreous anti-corrosion stove enamel. Price complete **£14/19/6**, plus 3/6 p. and p. H.P. Terms available. The above described treble speakers are available separately and are without doubt the most sensitive and efficient treble reproducers to date. Price **28/6**, plus 11/- P. Tax, plus 2/- p. and p.

VALVES

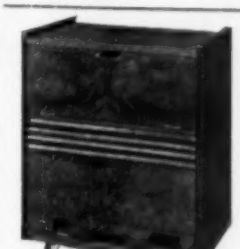
We have perhaps the most up-to-date valve stocks in the trade. A stamp will bring complete list but the following is a selection only of brand new imported valve types, fully guaranteed. Purchase Tax Paid.

EABC80	10/-	DAF96	10/6	PY80	10/6
EAF42	10/-	DF96	10/6	PY81	10/-
EB41	7/6	DK92	10/6	PY82	9/6
EB91	7/6	DK96	10/6	PY83	11/6
EBC41	10/-	DL96	10/6	UBC41	10/6
EBF80	11/6 or **20/6** per set			UCH42	11/6
ECC81	9/- of four.			UF41	10/6
ECC82	9/-	DM70	9/-	UL41	10/6
ECC83	9/-	EL41	10/6	UY41	9/-
ECC84	15/-	EL84	11/6	6AQ5	8/6
ECC85	10/-	EM80	9/-	6AT6	8/-
ECF82	15/-	EY51	12/-	6AU6	9/6
ECH42	11/6	EZ40	8/6	6BA6	8/6
ECH81	11/6	EZ80	8/6	6BE6	9/-
ECL80	11/6	PCF80	12/6	6BW6	8/6
EF41	10/6	PCF82	12/6	6X4	7/6
EF80	10/6	PCC84	12/6	35W4	7/6
EF85	10/6	PL81	13/6	50B5	10/-
EF86	12/6	PL82	10/6	50C5	10/-
EF89	10/-	PL83	11/6		

In addition we naturally have all usual surplus types available such as 6V6GT, etc. All in our valve price list!

BRAND NEW C.R. TUBES.—By leading manufacturer, 12 in. equivalent to MW 31/74 **£11/19/6**. 14KP4A. Tinted. Latest type 14in. rectangular 6.3 v. heater. 12-14 Kv. in original sealed cartons. Limited quantity only at **£13/19/6**. Ditto 17in. type 17ASP4, price **£18/19/6**. All H.P. available. Plus 15/- packing, carriage and insurance.

TRANSISTORS! MULLARD TYPE OC.71. Available ex stock at new list price of **30/-** each, post free.



Another Cabinet Bargain! Special purchase of walnut veneered trolley-type cabinets, originally intended for use in projection T.V. Easily recognised as being of leading High Quality manufacturer's stock, heavy dark solid walnut. Can be easily adapted to house tape recorder, amplifier, radiogram, etc., etc. Measurements external 24½in. × 16in. × 29in. The whole is mounted on castors. Unrepeatable bargain at **£5/19/6**, plus 10/- packing and carriage. We have a large selection of all type cabinets. A stamp will bring list.

I.F. STRIP. Ex-Govt. Brand new condition, for 9.72 mc/s., but easily converted if necessary. Band width 180 kc/s. Less valves. Price 15/- only. Limited supply.

POWER PACK. By leading manufacturer. Input 200/250 v. Output 350-0-350 280 mA., 6.3 v. 8 a., 6.3 v. 2 a., 4 v. 7 a., 5 v. 3 a. Fully smoothed. Incorporates valve rectifier GZ32. Chassis measures 13in. × 7in. × 5½in. Wt. 22lb. Few only at **£4/19/6**, plus 5/6 p. and p.

CLYNE RADIO LTD.

18, Tottenham Court Road, London, W.1.

LASKY'S RADIO

SAVE POUNDS! ORDER BY POST IF YOU CANNOT CALL

WIDE ANGLE 14-INCH CONVERSION PARCEL

Convert to big 14-inch picture! Parcel contains brand new 14in. rectangular C.R. tube (famous make), 6.3 heater, 10-14 Kv. E.H.T. aluminised, 1 Ferroxcube line output trans. with width and linearity controls, Ferroxcube scanning coils, frame output trans., Ferroxcube focus magnet, duodecal base, 14in. mask, suggested circuit diagram.

LASKY'S PRICE, complete parcel, **£18.5.0**

Carr. and insur., 25/-. All parts and C.R.T. available separately.

METER BARGAINS

2½in. moving coil. Brand new micro-ammeters F.S.D. 0-750 micro/amps., 15 ohms resist., **21/-**
0-1.5 amps., **12/6**. 0-300 v., A.C., rect. incorporated, **12/6**.

DOZENS OF OTHER TYPES.

5-CHANNEL BAND 1 TV PRE-AMPLIFIERS

Famous make, brand new and unused. Contains 1 6AM6 valve. Size 5 × 2 × 2in. List 45/-. **LASKY'S PRICE** **21/-**
Post 2/6.

PROJECTION TV UNITS

(Mullard). Consisting of optical unit and E.H.T. unit, complete with valves and C.R. tube. Limited quantity. Full details on request.

LASKY'S PRICE **£21**

Carr. 21/-.

FEW ONLY

21in. C.R. TUBES

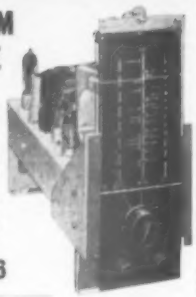
£24

COMPLETE 5-VALVE RADIO CHASSIS

Brand new and unused. A.C./D.C. 200/250 volts. I.F. 465 kc/s. A.V.C. 4 watts output, 3-station pre-set, frame aerial, fully aligned, chassis 10 × 5½in. max. height 5½in. Completely wired and ready for use, with the addition of a speaker and output transformer. Two controls, volume and station switch. Valves used: 10C1, 10F9 or UF41, 10LD11, 10P14, U404 or UY41.

REDUCED PRICE, less valves, **52/6**
Post 3/6.

6-VALVE RADIOGRAM CHASSIS COMPLETE WITH VALVES



Famous Maker's Surplus. Brand new 6-valve, 3-wave Superhet, 13-50 m., 200-550 m., 1,000-2,000 m. Brand new Mullard valves: ECH42, EF41, L63, EB41, 6V6, g.t., EZ40, and finest quality components. Gram. switch, 465 Kc/s. I.F., tone control, 3-colour dial. Overall size: 13½ × 5, height 12¼in. Aperture required for dial and controls 11 × 3½in. Complete with valves, output trans., knobs, etc.

LASKY'S PRICE **£10.19.6**
Carr. & Pkg. 7/6 extra.

5-VALVE RADIOGRAM CHASSIS

Latest type miniature valves. A.C. mains, 3-wave superhet. Large full vision dial, 11½in. × 4½in. Overall dimensions 14 × 6½ × 7in. Valve line-up, 12AN8, 6BA6, 6AT6, 6BW6, 6X4. **£9.19.6**

LASKY'S PRICE, complete with valves,
Carr. 7/6.

TABLE CABINET for above, complete with 6½in. P.M. speaker, 49/9.

3-SPD. MIXER AUTO-CHANGERS

ALL BRAND NEW AND UNUSED, IN MAKERS' CARTONS

GARRARD RC.110. As illustrated. Complete with t.c. crystal pick-up. Cabinet space required 14 × 12½ × 4in. above, and 2½in. below motor board. Cream and brown enamel finish. Complete with instruction book. Limited quantity only. List, £14/13/-.

LASKY'S PRICE **£8.19.6**
Carr. 5/-.

CABINETS AVAILABLE. Prices on request.

GARRARD RC.80. Full length arm with two Decca X98 heads. Limited quantity only. List £20/15/0.

LASKY'S PRICE **15 Gns.**
Carr. 5/-.

Also available with GC.2 t.c. crystal head at same price.

B.S.R. MONARCH. Latest model, with HGP.37 t.c. crystal pick-up. Cream finish.

LASKY'S PRICE **£7.19.6**
Carr. 3/6.

COLLARO RC.54. With Studio O turnover crystal pick-up. **£9.19.6**

SINGLE RECORD PLAYERS

Complete with pick-up.

COLLARO 3/554	£8 18 4
B.S.R. Model TU.8	£4 17 3
GARRARD "T" (X98 heads)	£12 12 0

Carr. 3/6.

ACOS TURNOVER CRYSTAL CARTRIDGES

HUG type HGP.37, as used in latest radiograms. L.F. and standard. Complete with stylii. **22/-**
Post 1/-.

Also, another well-known make at **18/6**
Post 1/-.

DECCA PICK-UPS

3-spd. with t.c. crystal head H.U.G. and rest. Brown plastic.

42/6

Post 2/6.

HI-FI ELECTROSTATIC SPEAKERS ('TWEETERS')

For high fidelity sound reproduction. Easily fitted to any radio, TV or amplifier. Full data and diagram supplied.

LSH150. 7-18 kc/s., 20 dbs. inherent esp. 1,100 p.f. For outputs up to 20 watts. Size 5 × 4 × 1in. **21/-**.

LSH518. As above, for outputs of 10-12 watts (wide angle sound distribution). Size 7 × 2 × 1in. **17/6**.

LSH75. Inherent esp. 800 p.f. For outputs up to 6 watts. Size 3 × 3 × 1in. **12/6**.

All post free.

PORTABLE GRAM AMPLIFIER

Uses 3 latest miniature valves, U78, N78, DH77. Volume, base and treble controls; extension L.S. socket and internal L.S. switch. Indicator lamp mounted on wood baffle, overall size 14 × 4½in. with speaker centralised. All top quality new components. For A.C. mains, 200-250 v. Ideal for portable record players, input will match Monarch, RC54, RC3/554, etc.

Price, complete with 3 new Osram valves, 7 × 4in. Goodmans elliptical speaker, metal speaker grille, mains cad, and knobs.

£5 . 9 . 6

Post & Pkg. 5/-.

12-CHANNEL TV TUNER

Famous make. Covers Bands I and III. Complete with valves EF80 and ECC81. Ceramic valve holders, finest quality components. Switch and fine tuning. I.F. output 20-25 Mc/s. Freq. coverage 50-67 Mc/s. and 175-215 Mc/s. Full details and circuit diagram supplied.

Post 3/6. **KNOB, 2/9 extra.** **89/6**

TELETRON BAND III CONVERTERS

MK. I. Complete Kit to build this converter, drilled chassis, condensers, resistances, coils, 2-E88C valves, etc., with circuit diagram and instructions. **48/6**
Post 1/6.
Drilled chassis only, 3/9.

Mk. II. Uses latest type valves, Cascode R.F. amp. and triode pentode F.C. PCC84 and PCF80, etc. The **COIL SET.** **17/6**

COMPLETE KIT, including drilled chassis, valves and diagram, **59/6**
Post 1/6.
Circuit diagram only, 3d.

TELETRON CONVERTER COIL SET. For use with TRF and 8'bet Band I TV sets. Uses two Z719. Circuit diagram, alignments, full details supplied. **15/-**
Post 1/6.

MAKERS' SURPLUS TV COMPONENT BARGAINS

WIDE ANGLE 20 mm.

Line E.H.T. trans., Ferroxcube core, 9-16 kV	25/-
Scanning Coils, low imp., line and frame	25/-
Ferroxcube cored Scanning Coils and Line Output Trans., 10-15 kV, EY51 winding. Line trans. incorporates width and linearity control. Complete with circuit diagram, the pair	50/-
Frame Output Transformer	10/6
Scanning Coils, low imp., line and frame	17/6
Frame or line blocking osc. trans.	4/6
Focus Magnets Ferroxdure	19/6
P.M. Focus Magnets, iron cored	19/6
Duomag Focalisers	22/6
300 mA. Smoothing Chokes	15/-
Electromagnetic Focus Coil with combined scan coils	25/-

STANDARD 28 mm.

Line Output Trans., no E.H.T.	12/6
Line Output Trans., 6-9 kV. E.H.T. and 6.3 v. winding Ferroxcube	19/6
Ditto, by Igranic	14/6
Frame or line blocking Osc. Trans.	4/6
Frame Output Transformer	7/6
Focus Magnets, without Vernier	12/6
With Vernier	17/6
Focus Coils, electromagnetic	12/6
200 mA. Smoothing Chokes	10/6

HI-FI EQUIPMENT

Large stocks of leading makes of Hi-Fi Amplifiers, Speakers, etc.

MORE MONEY-SAVING LASKY BARGAINS ON NEXT PAGE

RADIO · TELEVISION · HI-FI · ELECTRONICS · RECORDERS

LASKY'S RADIO

BAND III CONVERTERS

2 valves and metal rectifiers, metal case. Contains power pack for 200-250 v. A.C. List £8/10/-.
LASKY'S PRICE **£5.19.6**

R1155 RECEIVERS

In original wood transit cases.
Brand New £11 19 6
Second-hand Grade 1 £9 19 6
Second-hand, Grade 2 ..... £7 19 6
Carr. 12/6.
Power Pack and Output Stage with 6½in. Speaker .. £5 5 0

FILAMENT TRANSFORMERS

6.3 v. 1.5 amp. 5 11
6.3 v. 3 amp. 7 6
6.3 v. 1 amp. 4 6
0-30 volts 19 6

3-WATT AC/DC MIDGET AMPLIFIER

Push pull, very high gain. 4 valves: two UL41 (p.p.) UCH42, UAF42. Input voltage 100/100 A.C./D.C. Easily converted to 230 v. Ideal for record players, tape recorders, baby alarms, etc. Supplied fully assembled with valves, circuit diagram and details.
REDUCED TO **50/-**
Carr. 5/-.

TRANSISTORS and Transistor components in stock.

LASKY'S RADIO CONSTRUCTOR PARCELS

No. 1. Contains everything to build a 4-valve, 3-wave superhet for 200-250 A.C. mains. Wood or plastic Cabinet as preferred. Can be built for **£7.19.6**

No. 2. Contains everything to build a T.R.F. 3-valve, 3-wave set for 200-250 A.C. mains. Wood or plastic cabinet as preferred. Can be built for Carr. 2/6. **£5.10**

INSTRUCTION BOOKS for above, 1/- each, post free. All components available separately.

FAMOUS AMPLIFIERS BUILT ON T.C.C. PRINTED CIRCUITS

All specified components used, with your choice of transformers and chokes. Fully assembled and ready for use.

The **MULLARD 510.** Price, according to transformers used, from 15 **gns.** The Book, 3/6, post free.

THE OSRAM 912.
From 19 GNS.

The Book, 4/-, post free.

All components available separately, also printed Circuits.

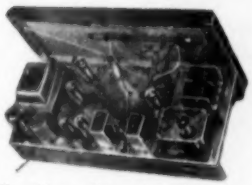
MOVING COIL SPEAKERS

5in., 18/6; 6½in., 19/6; 6½in. with trans., 22/6; 8in., 25/-; 10in., 26/6; 12in., 29/6.
7×4in. elliptical, 19/6.

HIRE PURCHASE TERMS

available on certain items. Write stating your requirements.

LASKY'S NEW 1956 AM/FM S'HET RADIOGRAM CHASSIS



Very latest circuit covering L., M. and S. wavebands as well as F.M. 8-valve p.p. output. Ferromagnetic aerial, p.u. sockets, ext. speaker sockets and provision for electrostatic Tweeter. Magic eye tuning indicator. For A.C. mains 200-250 v. Valve line up: ECC85, ECH81, EF89, EABC80, ECC82, two 6BW6 (p.p.) 5Y3 rect. Incorporates latest Gorler F.M. components including front end UT3-v0. Large full vision dial, size 14¼ × 6in. Overall dim. of complete chassis, 15×7½×8in. high.

LASKY'S PRICE **26 GNS.** Carr 6/6.

DULCI F.M. TUNER

Incorporates its own power supply and provides complete F.M. coverage. Operates with most radio receivers and any make of Amplifier. Valve line up: EABC80, ECC85, two EF89, 6X4 (Rect.), EM80 Indicator. Incorporates GORLER Inductance Tuning Heart, and magic eye tuning indicator. Dial 10½ × 6in. Overall size 9 × 6 × 5½in. high.
Complete **16 GNS.**
Carr. & Pkg. 7/6

DENCO F.M. COMPONENTS

Coils, each 3 11
I.F.'s, each 7 0
Ratio Disc 12 6
Chassis & Screens .. 7 6
Dial and Drive 9 0
Valves (5) 42 6
Post 1/-.

20,000 VALVES

in stock. Write for our latest price list.

JASON F.M. TUNER

Special parcel containing data book, chassis, front end, dial, drive, tuning condenser, full set of coils, I.F.'s, ratio detector, etc. Post 2/6 **68/9**
Book only, with price list, 2/-

This Tuner uses 4-6AM6 and 2 crystals and can be built for **£6.15.** Plust 3/6 post.

THE NEW JASON 'ARGONALIT' AM/FM TUNER-RECEIVER

A super-sensitive Tuner-Receiver for F.M. and medium waves only. All components available separately. Send for itemised price list.
COMPLETE KIT with output stage **£15.5**
Carr. 3/6.

CHASSIS ASSEMBLY
Complete **57/9**
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I.F. AND COIL SET Complete. Post 1/6 **78/-**

DENCO F.M. FEEDER UNIT

Uses 6AM6, 12AH8, EB91 and two 6BA6. Complete parcel **£6.7.6**
Data Book only 1 6

LATEST BRENELL TAPE EQUIPMENT

The DECK. 3-speed, 3 motors, record and play back. **18 GNS.**

The AMPLIFIER Mk. II, 5 watts, for use with 3 ohms speakers. Magic eye. **18½ GNS.**

CARRYING CASE £5 15 0

COMPLETE EQUIPMENT with mike and tape, ready for use, with carrying case. **51 GNS.**

Full details on request.

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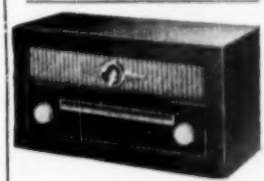
Kraft base, length 1,200ft., Cyldon metal spool. Post 1/-. **12/11**

All makes of Tape stocked including the new thin long playing tape. Scotch Boy, E.M.I., Grundig, Puretone Ferrograph, Basf, Agfa, Gevaert. All types of spools.

STEEL CHASSIS

18 S.W.G., undrilled, 4 sides, reinforced corners. Depth 2½in.
6×4 4/-; 12×8 7/-; 16×10 8/3; 8×6 5/-; 14×9 7/6; 12×3 4/9; 10×7 6/-; 16×9 8/-; 12×6 6/6.
Post 1/- per chassis extra.



T.S.L. "EMPRESS" F.M. TUNER

A high-grade unit complete with power supplies. Incorporates the latest Gorler F.M. components including the permeability tuned front end. Freq. coverage 86-103 Mc/s. Two controls. Valve line up: ECC85, two 6BJ6, 6AL5, EZ80. Chassis only. Post 3/6 **£14.18**

IN CABINET, as illus., with magic eye tuning indicator. Post 3/6 **£17.12.6**

HANDBOOK giving full details for home construction, 2/6. Can be built for **10 gns.** All components available separately, list on request.

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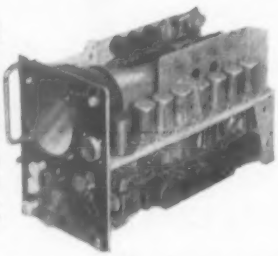
TYPE 62A INDICATORS



Ideal for conversion to oscilloscopes, T.V. units, etc. Containing V.C.R.97, 12 VR.91 (EF.50), 2 VR.54 (EB.34), 3 VR.92 (EA.50), 4 CV.118. (SP.61) Slow-motion dial, 13 Pots and scores of useful components. Size: 8½in. × 11½in. × 18in. In wooden packing case. **£3**, carriage 7/6.

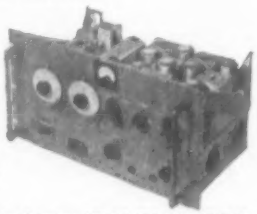
MINIATURE I.F. STRIPS. Size 10¼in. × 10½in. × 3in., frequency 9.72 Mc/s, 2 EF.92's and 1 EF.91. I.F. amps. EB91, DET/AGC EF.91, AGC. Amp. and EF.91 limiter. Circuit supplied. Price less valves, 8/- each, post paid.

ADMIRALTY RESPONSER UNIT: Type W.4790. This receiver tunes from 160-182 megs. Valve line up: VR.136 RF., VR.92 Mixer, VR.137 Osc., VR65s in 5 I.F. stages. VR.92 Det. output. Modification details avilable to tune over approx. 80-100 megs. Price 12/6 each fully valved. Post and Pkg. 7/6.

BENDIX I.F. Transformers, 1.63 Mc/s, complete in cans, set of two, new and boxed, size 2 × 1½ × 3½in., 5/-, p.p. 1/6.

BENDIX potted Audio Output Transformer, complete with integral smoothing choke. Ratings 4½ watt, 9,000 ohm primary, 600 and 4,000 ohm secondary. Size 4 × 1½ × 2in. New and boxed. 4/6, p.p. 1/6.

2 METRE RECEIVER Type R1392



Air Tested

15 Valve Superhet

Frequency 95-150 Mc/s

(2 to 3 metres)

Valve line up: 1st and 2nd R.F. Amp. VR.136 (EF.54). 1st Local Oscillator VR.65 (SP.61). 2 Oscillator Multipliers VR.136 (EF.54). 3 I.F. Amp. VR.53 (EF.39). A.G.C. 6Q7. Output 6J5. Muting VR.92 (EA.50). Noise Limiter VR.92 (EA.50). B.F.O. 6J7. Mixer VR.136 (EF.54). De Mod. 6Q7.

Slow motion tuning; normally crystal controlled, or tunable over 95-150 Mc/s. Power supply required: 240-250 volts at 80 mA., 6.3 volts, at 4 amps.
Size 19in. × 10in. × 10in. Standard Rack Mounting.
£6/19/6. Complete with valves and circuit diagram, checked and Air Tested. Packing and postage 17/6, 10/- returnable on packing case.

Power Pack Type 234 for use with R1392, £4/10/-, pkg. and post 7/6.

TRANSMITTER Type T1131-L

Frequency 100 to 156 Mc/s. Output 50 W. Crystal controlled. 200-240 v., 50 c.p.s. Power supply. Housed in 6ft. standard on 19in. rack. In new condition complete with valves.

Send for full details.

EDDYSTONE RECEIVERS B34

with coils £8/10/-, plus carriage. (Send for details).

BC-610 TUNING UNITS

TU49-3 to 4 Mc/s. TU50-4 to 5 Mc/s., 12/6 post paid.

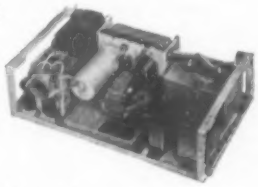
AMERICAN CLOCKWORK INTERVALOMETER

72-hour jewelled compensated movement. Contacts make every 15 seconds. Can be easily converted to give variable time delay. Panel mounting 3in. × 3¼in. Brand new, 12/6, plus 1/6 p.p.

TUNING UNITS Type T.U.5B

This well-known Tuning Unit has a frequency of 1500-3000 kc/s with 2% accuracy. Micrometer Dial that provides 2,500 divisions over 180° rotation of the tuning shaft which gives plenty of mechanical band spread from 3.5 Mc/s through 28 Mc/s. In addition the unit has a High C Tank Circuit with temperature compensating coil. The above Tuning unit from the BC-375 Transmitter needs only a few additional small parts to convert into a stable Temperature-Compensated VFO which may be used to replace the Crystal in Crystal Controlled Transmitters. Conversion Details and Circuit Diagrams supplied FREE with unit. Price 15/- each, plus 4/- packing and postage.

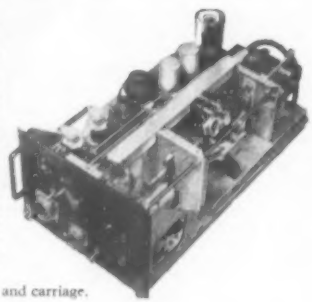
POWER UNIT Type 173



12 or 24 Volt D.C. Input, 120 v. 60 mA. output. Containing Vibrator Transformer, 12 volt Vibrator, two 120 volt Selenium Rectifiers, Chokes and Condensers. Size 10½in. × 6in. × 3in.

Price 12/6 post paid.

A.P.Q.9 RADAR JAMMING UNIT



Containing 913A Photo Multiplier Cell, complete with resistance network and lightproof box. Wide band amplifier (2) 6AC7 and 6AG7, driving a pair of parallel 807s which Grid modulate a pair of 8012s in push pull, Lecher lines, these cooled by blower motor. Cathode loaded by Co-axial stubs which simultaneously guillotine tune anode and grid lines with a counter mechanism. Output is matched to aerial by a matching stub. Suitable for use in centimetric bands. Brand new. Price £5, plus 10/- packing and carriage.

A SELECTION OF EX-GOVERNMENT SURPLUS VALVES

	Each		Each		Each
6SQ7	6/-	6AL5	7/-	VR.54	2/-
6G6G	5/-	6H6.G	2/-	VR.55	6/-
6L7M	6/-	6H6.M	3/-	VR.56	5/-
6F7G	6/-	6C4	4/6	VR.65	3/6
6SG7M	6/-	6C5	5/-	VR.91	5/-
6SK7	5/6	6C8	6/-	VT.52	4/6
6B7	3/-	OD3	3/-	VT.501	4/6
37	5/-	1A3	4/6	CV.18	4/-
6D6G	5/-	1A5	4/6	CV.6	2/-
6F6M	7/-	5U4G	7/6	CV.63	2/-
6A6G	6/6	807	5/-	CV.72	4/-
6K6.GT	5/6	809	7/-	CV.73	5/6
6SN7.GT	6/6	866A	10/-	CV.339	4/-
6AG5	5/6	12SH7M	5/6	CV.349	4/-
6V6GT	6/6	12SJ7M	5/6	2B7G	4/6
6V6M	9/-	ARP.38	5/6	6L6G	7/6
6AK5	5/-	VR.53	5/6	6X5GT	7/-
6J6	5/-				

MICRO SWITCH

Universal type (make or break on depression) 5A, 250 v., housed in strong aluminium casting. 2¼in. × 1⅝in. × 1in., with roller on operating lever. Price 3/- p.p.

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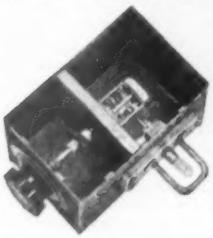
PROOPS BROS. LTD. — *The Walk-around Shop*

RECEIVER TYPE BC.733

Frequency 100 Mc/s. approx. Four crystal tuned frequencies. 6.9 Mc/s. I.F.s easily altered to 10 Mc/s. Suitable for conversion to F.M. Containing four crystals, two full-wave instrument Rectifier bridges, 90 and 150 cycle tone filter units. Valve line-up: (3) 717A. Low noise mush-room pentodes. (2) 12SG7; (1) 12AH7; (3) 12SR7; 12A6 output. Price £5. Carriage and Packing 7/6.



ABSORPTION WAVEMETER

Easily converted to 2 metres or 70 cm. in copper-plated metal case 3½ × 4½ × 5½in. with dial calibrated 0-100 and 80V Neon Tube. Coverage approx. 190-210 Mc/s. New. 6/6 each, post paid.

FL-8 RADIO FILTER UNITS

Size 2½ × 2½ × 3in 10/- plus 1/6 p.p.

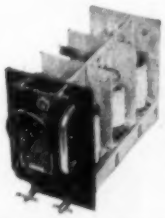
R.F. UNITS

R.F.24 20-30 Mc/s. Switched Tuning, Valved. 9/6 each.

R.F.25 40-50 Mc/s. Switched Tuning. Valved. 9/6 each.

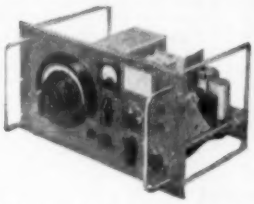
R.F.26 50-65 Mc/s. Variable Tuning. Valved (new). 25/- each.

Packing and postage 2/- each.



RECEIVER TYPE R 1132

Frequency 100-126 Mc/s. 11-valve Superhet.



Valve line-up: R.F. Amplifier VR.65 (SP.61); Frequency changer VR.65 (SP.61); Local Oscillator VR.66 (P.61); Stabilizer VS.70 (7475).

3 × I.F. Amplifiers VR.53 (EF.39); B.F.O. VR.53 (EF.39); Detector VR.54 (EB.34); A.F. Amplifier VR.57 (EK.32); Output VR.67 (6J5).

Switchable A.G.C. and A.V.C. Variable B.F.O.

Circuit diagrams with units. Easily converted to cover Wrotham Band. No alterations to wiring required. Conversion Slugs and instructions, supplied free. Size 19 × 10 × 10in. Standard Rack Mounting.

PRICE £3/7/6. Packing and carriage 15/-. 10/- returnable on Packing Case.

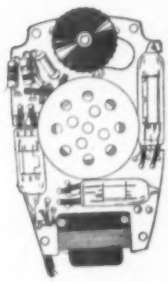
2-3mA MEASUREMENT METER

2-3 mA movements in metal case measuring 4¼in. high, 3¼in. wide and 5in. deep. 7/6 plus 2/- p.p.

INSULATION TAPE

Perfect condition. ½in. wide, 25 yd. reels, foiled, in tins, 1/3 each, p.p. 8d.

Make a miniature POCKET RADIO



Incorporating high "Q" technique using the New Ferrite rod. Made possible by simple conversion of an ex-Govt. Hearing Aid.

Technical Details. A Germanium Diode Dector circuit followed by the existing 3-valve Amplifier, giving adequate amplification throughout the medium wave band.

This conversion can be carried out in approximately 30 minutes.

SEE and HEAR this Miniature POCKET RADIO demonstrated.

THE COMPLETE KIT OF PARTS includes a Type OL10 Hearing Aid (with Crystal microphone) in perfect working order with miniature earphone and moulded ear insert attached: ferrite rod, germanium diode, components, circuit diagram and full instructions. Price **£2/6/-** *(less batteries)* post paid. **ALL COMPONENTS SOLD SEPARATELY.**

Deaf Aid Unit with earpiece....	£1 15 0
Plastic Ear Mould.....	2 0
Ferrite Rod.....	5 0
Conversion Components	4 0
Batteries 1.5 v. L.T. (Type D. 18)	8
30 v. H.T. (Type B.119)	4 3

NOTE: As the crystal microphone is not used in the Pocket Radio, it can, if desired, be used as a general microphone and it does not require a matching transformer.

THROAT MICROPHONES TYPE TS30

U.S. manufacture. Complete with elastic strap. Lead terminating at plug PL291. New and boxed. 2/3 post paid.

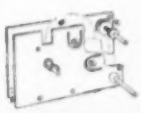
Sockets available at 6d. each.

MICROPHONES

E.M., with switch. Boxed, new, 1/6 p.p.

AR 88 RECEIVER

Slow-motion drive mechanism. New and boxed. 10/6 each, plus 1/6 p.p.



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3-pin 5 amp., non-reversible. Suitable for caravan and trailers, etc. 1/3 per pair, post paid.

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Size 2½ × 3 × 2½in. 10/6 each. 1/6 p.p.

REFLECTOR in Bakelite Case

fitted with small bayonet cap holder. Size 5in. in diameter by 3in. deep. 2/6 post paid.

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R.S.C. BATTERY CHARGING EQUIPMENT.

All for A.C. MAINS 200-250 v., 50 c/cs. Guaranteed 12 months.

ASSEMBLED CHARGER
6 v. or 12 v. 2 amps.
Fitted Ammeter and selector plug for 6 v. or 12 v. Louvred metal case, finished attractive hammer blue. Ready for use With mains and output leads, Double Fused.

Only **45/9** carr. 3/6.

ASSEMBLED CHARGERS
6 v. 1 amp. 19/9
6 v. or 12 v. 1 amp. .. 25/9
6 v. 2 amps. 29/9
6 v. or 12 v. 2 amps. 38/9
6 v. or 12 v. 4 amps. 56/9
Above ready for use. Carr. 2/9

HEAVY DUTY KIT
12 v. 30 amp. Suitable for Garage or firm with a number of vehicles. Mains input 200/250 v. 50 c/s. Outputs 12 v. 15 amp. twice. Consists of Mains Trans. 2 Metal Rectifiers. 2 Meters, 4 Fuses, 4 Terminals, 2 Rheostats and circuit. Only **9 gns.**, carr. 15/-.

BATTERY CHARGER KITS
Consisting of Mains Transformer, F.W. Bridge, Metal Rectifier, well ventilated steel case, Fuses, Fuse-holders, Grommets, panels and circuit. Carr. 2/6 extra.
6 v. or 12 v. 1 amp. .. 22/9
6 v. 2 amps. 25/9
6 v. or 12 v. 2 amps. .. 31/6
6 v. or 12 v. 4 amps. .. 49/9

BATTERY CHARGER KIT
Consisting of F.W. Bridge Rectifier 6/12 v. 5 a. Mains Trans., 0-9-15 v. 6 a. output, and variable charge rheostat with knob. Only 45/9.

Assembled 6 v. or 12 v. 4 amps.
Fitted Ammeter and variable charge selector. Also selector plug for 6 v. or 12 v. charging. Double fused. Well ventilated steel case with blue hammer finish. **69/6**
Ready for use with mains and output leads. Carr. 3/6.

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L.T. Types		6/12 v. 6 a. ..	19/9
2/6 v. ½ a.h.w.	1/9	6/12 v. 10 a.	25/9
6/12 v. 1 a.h.w.	2/9	**H.T. Type H.W.**	
F.W. Bridge Types		120 v. 40 mA.	3/9
6/12 v. 1 a. ..	5/9	250 v. 50 mA.	5/9
6/12 v. 2 a ..	8/9	250 v. 80 mA.	7/9
6/12 v. 3 a. ..	12/9	250 v. 150 mA.	9/9
6/12 v. 4 a. ..	16/9	300 v. 275 mA.	12/11

CO-AXIAL CABLE. 75 ohms ¼in., **8d.** yard. Twin screened feeder, **11d.** yard.

T.V. CABINETS. Console type for 15, 16 or 17in. tube. Half length doors, **9 gns.** Table model with doors for same size tube, **69/6.** Table type for 12in. Tube **29/6.** All famous manufacturers surplus.

SILVER MICA CONDENSERS. 5, 10, 15, 20, 25, 30, 35, 50, 100, 120, 150, 180, 200, 230, 300, 330, 400, 470, 500, 1,000 pfd. (.001μF), .002 mfd. (2,000 pfd.). All at **6d.** each, 3/9 dozen one type.

DIAL BULBS, M.E.S., 8 v. 0.2 a., 6/9 doz.; 6.5 v. 0.3 a., 6/9 doz.; 4 v. 0.3 a., 5/9 doz.

ELECTROLYTICS (current production) NOT Ex-Govt.

Tubular Types		Can Types	
8μF 450 v. ...	1/9	8 mfd. 350 v.	1/3
8 mfd. 500 v.	2/6	8 mfd. 600 v.	2/11
16μF 350 v. ..	2/3	16 mfd. 500 v.	3/9
16μF 450 v. ..	2/9	16 mfd. 350 v.	1/11
16μF 500 v. ..	3/9	16μF 450 v. ..	2/9
32μF 350 v. ..	3/9	32μF 350 v. ..	2/11
32 mfd. 500 v...	5/9	32 mfd. 450 v.	4/9
8-16μF 500 v.	4/11	100 mfd. 450 v.	4/9
25μF 25 v.	1/3	8-8μF 450 v. ..	2/11
50μF 12 v.	1/3	8-16μF 450 v.	2/11
50μF 50 v.	1/9	16-16μF 450 v.	3/11
100 mfd. 12 v.	1/9	16-32μF 350 v.	4/9
100 mfd. 25 v.	2/3	32-32μF 450 v.	5/9

Many others in stock.

VOLUME CONTROLS with long spindles, all values, less switch, 2/9; with S.P. switch, 3/9.

VIBRATORS. Oak 2 v. 7 pin, synchronous, **7/9.**

EX GOVT. E.H.T. CONDENSERS
.5 mfd., 2,500 v. Blocks 3/9
.5 mfd. 3,500 v. Cans 3/3
.1 mfd. plus 1 mfd. 8,000 v., large blocks (common negative isolated) 9/6

EX GOVT. METAL BLOCK PAPER CONDENSERS

2 mfd. 500 v.	1/9	8-8 mfd. 500 v.	5/11
4 mfd. 500 v.	2/9	15 mfd. 500 v	7/9
4 mfd. 1,000 v.	4/3		
4 mfd. 400 v. plus 2 mfd. 250 v.			1/11

EX GOVT. VALVES. VR137 EA50. EB34. **11d.**; SP61 2/3, 4SHA 1/3. EL32 3/9.

EX GOVT. UNITS, type RDF1 in original sealed cartons with 14 valves including 5Z4G etc., trans. L.F. choke, Rectifier etc., etc. We cannot enter into correspondence regarding these units which represent a really exceptional bargain at **29/9.** Carr. 7/6. Transmitter Receivers type TR9D complete with all valves **45/-,** carr. 6/6.

CONTROL PANEL with 1 six-position 3-wafer Yaxley switch, 1 pointer knob. 2 S.P.S.T. switches, various plugs and sockets. Only **1/9.**

OIL FILLED BLOCK CONDENSERS
Bryce 11-7 mfd. 500 v. New unused Govt surplus, only **5/9** each.

EX GOVT. MAINS TRANSFORMERS
All 230 v. 50 c/s. input.
8-8 v. 4 a., **9/9.**
300-0-300 v. 150 mA. 4 v. 3 a. 9/9
120-0-120 v. 40 mA. 5/9
250-0-250 v. 60 mA. 6.3 v. 2 a., 5 v. 2 a. Potted 4½-3½-3in. 11/9
460 v. 200 mA., 6.3 v. 5 a. 22/9
0-16-18-20 v. 35 a. **79/6** Carriage 5/- extra.

MANUFACTURERS SURPLUS TRANSFORMERS
Fully shrouded upright. Primary 200-230-250 v. Sec. 425-0-425 v. 150 mA. 6.3 v. 3 a. 5 v. 3 a., **33/9.** Clamped type 250-0-250 v. 70 mA., 6.3 v. 2.5 a. **9/9,** post 1/9.

EX GOVT. SMOOTHING CHOKES
250 mA., 10 H., 50 ohms. 14/9
250 mA., 3 H., 50 ohms. 8/9
150 mA., 10 H., 50 ohms. 10/11
150 mA., 6-10 H., 150 ohms., Tropicalised 6/9
100 mA., 10 H., 200 ohms., Tropicalised 3/11
50 mA., 50 H., 1,000 ohms. 6/9
L.T. type 1 amp., 2 ohms. 2/9

SPECIAL OFFERS. Small 2 gang variables .0005 mfd., 4/9, 8-8 mfd., 450 v. Electrolytics (midget) in lots of six, **1/6** ea.

R.S.C. BATTERY TO MAINS CONVERSION UNITS

Type BM1. An all dry battery eliminator. Size 5½ x 4½ x 2in. approx. Completely replaces batteries supplying 1.4 v. and 90 v. where A.C. mains 200-250 v. 50 c/cs. is available. **Suitable for all battery portable receivers requiring 1.4 v. and 90 v.** This includes latest low consumption types. Complete kit with diagrams **39/9,** or ready for use, **46/9.**

TYPE BM1A. An all dry battery eliminator size approx. 5 x 4 x 1½in. Supplies approx. 69 v. at 10-15 mA. and 1.4 v. at 250 mA. For 4 valve receivers using L.T. current of not less than 230 mA. Complete kit 35/9 or ready to use 42/6.

Type BM2. Size 8 x 5½ x 2½in. Supplies 120 v., 90 v., and 60 v., 40 m.A. and 2 v. 0.4 a. to 1 amp., fully smoothed **THEREBY COMPLETELY REPLACING BOTH H.T. BATTERIES AND L.T. 2v. ACCUMULATORS.** When connected to A.C. mains supply 200-250 v. 50 c/cs. SUITABLE FOR ALL BATTERY RECEIVERS normally using 2 v. accumulator. Complete kit of parts with diagrams and instructions **49/9,** or ready for use **59/6.**

R.S.C. TRANSFORMERS

FULLY GUARANTEED, INTERLEAVED AND IMPREGNATED

MAINS TRANSFORMERS
Primaries 200-230-250 v. 50 c/s.

FULLY SHROUDED UPRIGHT MOUNTING
250-0-250 v. 60 mA. 6.3 v. 2 a., 5 v. 2 a., Midget type, 2½-3-3in. 17/6
350-0-350 v. 70 mA., 6.3 v. 2 a., 5 v. 2 a. 19/9
250-0-250 v. 100 mA., 6.3 v. 4 v. 4 a., c.t., 0-4-5 v. 3 a. 25/9
250-0-250 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a. 23/9
250-0-250 v. 100 mA., 6.3 v. 6 a., 5 v. 3 a. for R1355 conversion 31/-
300-0-300 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a. 23/9
300-0-300 v. 100 mA., 6.3 v.-4 v. 4 a., c.t., 0-4-5 v..3 a. 26/9
350-0-350 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a. 23/9
350-0-350 v. 100 mA., 6.3 v.-4 v., 4 a., c.t., 0-4-5 v. 3 a. 26/9
350-0-350 v. 150 mA., 6.3 v. 4 a., 5 v. 3 a. 33/9
350-0-350 v. 150 mA., 6.3 v. 2 a., 6.3 v. 2 a., 5 v. 3 a. 33/9
425-0-425 v. 200 mA., 6.3 v. 4 a., c.t., 6.3 v. 4 a. c.t., 5 v. 3 a. suitable Williamson Amplifier, etc. 49/9
450-0-450 v. 250 mA., 6.3 v. 6 a., 6.3 v. 6 a., 5 v. 3 a. 69/6

TOP SHROUDED DROP-THROUGH TYPE
250-0-250 v. 70 mA., 6.3 v. 2.5 a. 13/9
260-0-260 v. 70 mA., 6.3 v. 2 a., 5 v. 2 a. 16/9
350-0-350 v. 80 mA., 6.3 v. 2 a., 5 v. 2 a. 18/9
250-0-250 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a. 22/9
300-0-300 v. 100 mA., 6.3 v.-4 v. 4 a., c.t., 0-4-5 v. 3 a. 23/9
350-0-350 v. 100 mA., 6.3 v. 4 a. c.t., 5 v. 3 a. 22/9
350-0-350 v. 100 mA., 6.3 v.-4 v. 4 a. c.t., 0-4-5 v. 3 a. 23/9
350-0-350 v. 150 mA., 6.3 v. 2 a., 6.3 v. 2a. 5 v. 3 a. 29/11
350-0-350 v 150 mA., 6.3 v. 4 a., 5 v. 3 a. 29/9

E.H.T. TRANSFORMERS, 2,500 v. 5 mA., 2-0-2 v. 1.1 a. 2-0-2 v. 1.1 a., for VCR97 VCR517 ..... 36/6

FILAMENT TRANSFORMERS
Primaries 200-250 v. 50 c/s.

6.3 v. 1.5 a. ..	5/9	0-2-4-5-6.3 v.	
6.3 v. 3 a. ..	8/11	4 a.	16/9
12 v. 1 a.....	7/9	6.3 v. 6 a. ..	17/6
6.3 v. 2 a. ..	7/6	12 v. 3 a. or	
0-4-6.3 v. 2 a.	7/9	24 v. 1.5 a.	17/6

CHARGER TRANSFORMERS
All with 200-230-250 v. 50 c/s. Primaries: 0-9-15 v. 1½ a., 11/9; 0-9-15 v. 3 a., 0-3.5-9-17 v. 4 a. **18/9.** 0-9-15 v. 5 a., **19/9.** 0-9-15 v. 6 a., **23/9.**

ELIMINATOR TRANSFORMERS
Primaries 200-250 v. 50 c/s. 120 v. 40 mA. 7/11
130 v. 50 mA., 6.3 v. 3 a. 14/9
120 v. 40 mA., 5-0-5 v. 1 a. 14/9
90 v. 15 mA., 6-0-6 v., 250 mA. 9/11

OUTPUT TRANSFORMERS
Midget Battery Pentode 66 : 1 for 3S4, etc. 3/6
Small Pentode, 5,000Ω to 3Ω 3/9
Standard Pentode, 5,000Ω to 3Ω 4/9
Standard Pentode, 8,000 to 3Ω 4/9
Battery Pentode, 10,000 ohms to 3 ohms. 4/9
Multi-ratio 40 mA. 30 : 1, 45 : 1, 60 : 1 90 : 1, Class B Push-Pull 5/6
Push-Pull 8 Watts 6V6 to 3 ohms. 8/9
Push-Pull 10-12 Watts 6V6 to 3Ω to 15Ω, sectionally wound 16/9
Push-Pull 10-12 Watts to match 6V6 to 3-5-8 or 15Ω 16/9
Push-Pull 15-18 Watts, sectionally wound, 6L6, KT66, etc., to 3 or 15 ohms. 21/9
Push-Pull 20 Watt high-quality sectionally wound, 6L6, KT66, etc., to 3 or 15Ω 47/9
Williamson type exact to spec. 85/-

SMOOTHING CHOKES
250 mA., 5 H., 100 ohms. 11/9
150 mA., 7-10 H., 250 ohms. 11/9
100 mA., 10 H., 200 ohms. 8/9
80 mA., 10 H., 350 ohms. 5/6
60 mA., 10 H., 400 ohms. 4/11

R.S.C. A6 ULTRA LINEAR 30 WATT AMPLIFIER

WE ARE PROUD TO INTR)DUCE OUR NEW 1956 DESIGN. A high Fidelity Push-Pull Unit employing six valves. Tone Control Pre-amp stages are incorporated. Sensitivity is extremely high. Only 30 millivolts minimum input is required for full output. **THIS ENSURES THE SUITABILITY OF ANY TYPE OR MAKE OF MICROPHONE OR PICK-UP.** Separate Bass and Treble controls give both "lift" and "cut" with ample tone correction for long playing records. **AN OUTPUT SOCKET WITH PLUG IS INCLUDED FOR SUPPLY OF 300 v. 20 mA. and 6.3 v. 1.5 a. FOR A RADIO FEEDER UNIT.** Price in kit form with easy to-follow wiring diagrams. Only **9 GNS.** Carr. 10/- Or Factory built with 12 months' guarantee, 50/- extra. **H.P. TERMS ON ASSEMBLED UNITS: DEPOSIT 28/6** and 12 monthly payments of 21/-. If required an extra input with associated vol. control can be provided so that two separate inputs such as "mike" and gram., etc., etc., can be simultaneously applied for mixing purposes. Extra cost for this 13/-. Cover as illustrated 17/6 extra.

Type 807 output valves are used with High Quality Sectionally wound output transformer specially designed for Ultra Linear operation. Negative feedback of 17 D.B. in main loop. **CERTIFIED PERFORMANCE FIGURES ARE EQUAL TO MOST EXPENSIVE UNITS AVAILABLE.** Frequency response ± 3 D.B. 30-20,000 c/cs., 12 D.B. "lift" at 50 c/cs., 12 D.B. "lift" at 12,000 c/cs. Hum and noise 70 D.B. down. Good quality reliable components used. Chassis finish blue crackle. Overall size 12 x 9 x 9in. approx. Power consumption 150 watts. For A.C. mains 200-230-250 v. 50 c/cs. Outputs for 3 and 15 ohm speakers. **EQUALLY SUITABLE FOR THE CONNOISSEUR OR FOR LARGE HALLS, CLUBS, or OUTSIDE FUNCTIONS. IDEAL FOR USE WITH MUSICAL INSTRUMENTS SUCH AS STRING BASS, ELECTRONIC ORGAN, GUITAR, etc. FOR DANCE BANDS, GARRISON THEATRES, etc., etc.** We can supply Microphones, Speakers, Rotary Converters, etc., at keen cash prices or on H.P. terms with amplifiers.

EXPORT ENQUIRIES INVITED

R.S.C. TA1 HIGH QUALITY TAPE DECK AMPLIFIER FOR ALL DECKS WITH HIGH IMPEDANCE RECORD/PLAYBACK AND ERASE HEADS. Such as Lane, Truvox and Collaro 3-speed transcriptor chassis, size 12-7-3in. Overall size 12-7-6½in. For 230-250 v. 50 c/cs. A.C. mains. Output for standard 2-3 ohm speaker. Only 15 millivolts input required for full recording. Only 2 millivolts minimum input required from recording head. Magic Eye recording level indicator. Provision for feeding P.A. amplifier. Can be used as gram. amplifier with input of 0.75 v. R.M.S. Negative feedback equalisation. Linear frequency response ± 3 D.B. 50-11,000 c/cs.

11 Ready for use. **GNS.** Carr. 7/6

Facilities for recordings at 15in., 7½in., or 3¾in. per second. Automatic equalisation at the turn of a knob. When switching from record to playback position automatic demagnetisation of heads is assured. **PERFORMANCE IS COMPARABLE WITH UNITS AT OVER TWICE THE COST. LEAFLET 6d.** **H.P. TERMS. Deposit 4 gns. and 6 monthly payments 1 gn.**

H.M.V. LONG PLAYING RECORD TURNTABLE COMPLETE WITH CRYSTAL PICK-UP (SAPPHIRE STYLUS). Speed 33⅓ r.p.m. BRAND NEW, CARTONED. Only **£3/19/6** (approx. half price). Carr. 5/- (for 200-250 v. A.C. Mains).

MICROPHONES. High fidelity crystal types. Acos 33-1 hand or desk type **50/-**. Pierzo with heavy floor base and telescopic stem, **£5/19/6**.

PLESSEY SINGLE SPEED AUTO-CHANGERS with Crystal Pick-up for standard 78 r.p.m. records 10in. or 12in. Very limited number. Only **£5/17/6**, carr. 5/6.

R.S.C. 4-5 WATT HIGH GAIN AMPLIFIER TYPE A5

A highly sensitive 4-valve quality amplifier for the home, small club, etc. Only 50 millivolts input is required for full output so that it is suitable for use with the latest high-fidelity pick-up heads in addition to all other types of pick-ups and practically all mikes. Separate Bass and Treble controls are provided. These give full long playing record equalisation. Hum level is negligible, being 71 D.B. down, 15 D.B. of negative feedback is used. H.T. of 300 v. 26 mA. and L.T. of 6.3 v. 1.5 a. is available for the supply of a Radio Feeder Unit, or Tape Deck pre-amplifier. For A.C. mains input of 200-230-250 v., 50 c/s. Output for 2-3 ohm speaker. Chassis is not alive. Kit is complete in every detail and includes fully punched chassis (with baseplate) with blue hammer finish, and point-to-point wiring diagrams and instructions. Exceptional value at only **£4/15/-**, or assembled ready for use **25/-** extra, plus 3/6 carriage.

R.S.C. A73-4 WATT QUALITY AMPLIFIER

A highly sensitive 4-valve amplifier using negative feedback and having an excellent frequency response. Pre-amplifier and Tone Control stages are incorporated with separate Bass and Treble controls giving full tone compensation for Long Playing records. Suitable for any kind of pick-up including latest high fidelity types. H.T. of 250 v. 20 mA. and L.T. 6.3 v. 1 a. available for supply of Radio Feeder Unit, etc. ONLY 40 millivolts input required for full output. Fully insulated chassis with baseplate. For A.C. mains 200-250 v. 50 cycles. Output for 2-3 ohm speaker. Complete kit of parts with point-to-point wiring diagrams and instructions. Only **£3.15/-**, carr. 3/6 or factory built **£2/6** extra.

BRAND NEW R.S.R. MONARCH 3-SPEED MIXER AUTO-CHANGERS. With crystal pick-up and dual point sapphire stylus for standard or long playing records. Plays ten 7in., 10in. or 12in. intermixed. For A.C. mains 200-250 v. 50 c/cs. Supplied in sealed cartons with template and operating instructions. Only **£7/19/6** plus 3/6 carr.

COLLARO HIGH FIDELITY MAGNETIC PICK-UPS. Low impedance with matching trans., brand new, boxed at fraction of normal price. Only **33/-**.

R.S.C. MASTER INTERCOMM. UNIT. With provision for up to 4 "Listen-talk Back Units" individually switched. A high gain amplifier enables speech and other sounds emanating from the rooms containing remote control units to be heard at the master control. Supplied with walnut veneered wood or brown bakelite cabinet. Mains input is 200-250 v. 50 c/s. H.T. line 300 v. CHASSIS IS NOT "ALIVE." Ideal for use as "Baby Alarm." Sound amplification 4 watts. Price only **7 gns.**, carr. 5/-. "Listen-Talk Back Unit" in bakelite or walnut veneered cabinet can be supplied at **35/-** each.

THE SKY FOUR T.R.F. RECEIVER

A design of a 3-valve 200-250 v. A.C. Mains receiver with selenium rectifier. For inclusion in either of cabinets illustrated above. It employs valves 6K7, 6P61, 6P60, and is specially designed for simplicity in wiring, sensitivity and quality is well up to standard. Point-to-Point wiring diagrams, instructions and parts list, **1/2**. This receiver can be built for a maximum of **£4/19/6** including cabinet. Available in brown or cream bakelite veneered walnut.

R.S.C. ULTRA LINEAR 12 WATT AMPLIFIER

NEW 1956 Model A8 High-Fidelity Push-Pull Amplifier with "Built-in" Tone Control, Pre-amp. stages. High sensitivity. Includes 5 valves (807 outputs), High Quality sectionally wound output transformer, specially designed for Ultra Linear operation, and reliable small condensers of current manufacture. **INDIVIDUAL CONTROLS FOR BASS AND TREBLE "Lift" and "Cut."** Frequency response ± 3 db 30-30,000 c/cs. Six negative feedback loops. Hum level 71 db. down. **ONLY 70 millivolts INPUT** required for **FULL OUTPUT.** Suitable for use with all makes and types of pick-ups and practically all microphones. Comparable with the very best designs. **For STANDARD or LONG PLAYING RECORDS. For MUSICAL INSTRUMENTS such as STRING BASS, GUITARS, etc. OUTPUT SOCKET** with plug provides 300 v. 20 mA. and 6.3 v. 1.5 a. For supply of a **RADIO FEEDER UNIT. H.P. TERMS ON ASSEMBLED UNITS. DEPOSIT 25/6 and nine monthly payments of 22/4.** Size approx. 12-9-7in. For A.C. mains 200-230-250 v. 50 c/cs. Output for 3 and 15 ohm speakers. **Kit** is complete to last nut. Chassis is fully punched. Full instructions and point-to-point wiring diagrams supplied. Unapproachable value at **£7/15/-**, or factory built **45/-** extra. Carriage 10/-. If required louvred metal cover with 2 carrying handles can be supplied for **17/6**. Where an extra input socket with associated volume control is required for mixing purposes this can be provided for **13/-** extra.

FOUR-STAGE RADIO FEEDER UNIT

Design of a **HIGH FIDELITY L. and M. wav** T.R.F. Unit with self-contained heater supply and thorough H.T. decoupling. Only 250-due v. 15-20 mA. H.T. required from main amplifier. Three valves and Low Distortion Germanium Diode Detector. Flat topped response characteristic. Loaded H.F coils. Two variable Mu controlled H.F. stages, 3 gang condenser tuning. Cathode follower output stage. Switch position for Gram. and Gram. input and output sockets. Performance comparable with the best in Feeder Units. For A.C. mains 200-230-250 v. operation. Size 11-6-7½in. Illustrations full set or easy-to-follow wiring diagrams and instructions and individually priced parts list **2/6**. This unit can be built for only **£3/15/-**, including Dial and Drive knobs and every item required.

DEFIANT RECORD PLAYING TURNTABLE COMPLETE WITH MAGNETIC PICK-UP. Pick-up to high impedance type. Unit is housed in a beautiful walnut veneered cabinet of attractive design. For all standard records (78 r.p.m.). Limited number. Brand new, cartoned, **£5/19/6**, carr. 7/6.

W.B. "STENTORIAN" HIGH FIDELITY P.M. SPEAKERS. HF1012, 10 watts, 15 ohm (or 3 ohm) speech coil. Where a really good quality speaker at a low price is required, we highly recommend this unit with an amazing performance, **£4/6/0**.

Radio Supply Co. (LEEDS) LTD.

32 THE CALLS. — LEEDS, 2.

Terms C.W.O. or C.O.D. No C.O.D. under £1. Postage 1/9 extra on all orders under £2, 2/9 extra under £5 unless carriage charge stated. Full Price List 6d. Trade List 5d. Open to Callers: 9 a.m. to 5.30 p.m. Saturday until 1 p.m.

GEE-RADIO LTD

R.C.A. BRAND NEW 15in. 15 ohms 30 watt P.M. SPEAKERS. Snip price **£9/19/6.** Carriage 12/6.

R.C.A. PRESSURE UNITS. 15 ohms. P.M. 20 watts. Complete with Exponential Horn, length 14in. dia. 17in., **£5/19/6.** Carriage 10/–.

COMMUNICATION RECEIVERS P.C.R. 2 waveband 13-49, 200-600, 800-2,100 metres. P.C.R.3. 13-49, 49-120, 200-550 metres. Both types in brand new condition. Fully tested before despatch. Price **£7/10/–** each. Carriage 7/6.

POWER PACKS for the above models available. A.C. mains. Built as for the R1155A and 1132A receivers. **£5.** Carriage 7/6.

R 1155A RECEIVERS. In good condition. **£8/10/–.** Carriage 7/6.

R 1132A RECEIVERS. In good condition. **£3/17/6.** Carriage 7/6.

POWER PACKS for the above, complete with speaker built into very attractive polished 8in. extension speaker cabinet. Ready for use on A.C. mains 200-250 v. **£5/10/–.** Carriage 7/6.

RECEIVER TYPE 109 in good condition. Freq. range 1.8-3.9 Mc/s. and 3.9-8.5 Mc/s. continuous. Operates on 6 v. battery. Price **£4/7/6** Carriage 10/6.

POWER PACK for the above **£4.** Carriage 5/6.

TELE-P. Sound powered telephones with ringing generator. Complete in wooden carrying case. Used but in sound condition. **37/6.** Carriage 3/6.

50 WATT EX GOVT. AMPLIFIER with 4-KT66's in paralleled push-pull. Standard 200-250 v. A.C. input. Output imped. 600 ohms. Line. High imp. gram and mike input. Bass boost control fitted. Quality amplifier housed in strong metal case ready for use. Terrific performance. Bargain price **£25.** Carriage extra.

METERS
1-0-1 milli-ammeters, flush mounting 4in. scale. **45/–.**
0-300 v. A.C. flush mounting 2½in. scale. **25/–.**
0-25 amp. D.C. flush mounting 2½in. scale. **12/6.**
0-15 v. and 0-250 v. D.C. pocket volt-meter 2½in. **15/–.**
AR-77 "S" meters 2in. **30/–.**
0-200 v. A.C. meters flush mounting 3½in. Grade 1. **40/–.**

WAVEMETER CLASS D. Freq. band 1,900 kc/s-8,000 kc/s. (158-37.5 m.) in two ranges, 1,900 kc/s-4,000 kc/s. Also 4,000 kc/s-8,0)0 kc/s in perfect working order. Supply 6 v. D.C. input. **£8/5/–.** Carriage paid.

CONDENSERS. 2 mfd. 7.5 kv. wkg. at 15 kv. test (Dubilier). Brand new in original crates. **£2/10/–.** Carriage 5/–.

VARIABLE VOLTAGE REGULATOR TRANS. Input 230 v. A.C. at 21 amps. Output 57.5 amps. in 16 equal steps to 230 v. at 21 amps. Ex. Govt. in perfect condition. Price **£12/10/–.** Carriage extra.

H-DUTY TRANSFORMERS L.T. 230 v. PRI-11-12.5 v. SEC at 70 amps. **£5/10/–.** Carriage 7/6.
DON "8" TWIN TELEPHONE CABLE on 1 mile and ½ mile drums. **£5** per mile, **25/–** per ½ mile. Carriage extra.

"AVO" MODEL 7. In perfect condition with leads and batteries (cases available). **£13/10/–.** Post 3/6.

WESTON BATTERY OSCILLATORS. Model E 692 Type 2. In perfect condition. Coverage 100 kc/s-20 Mc/s. Audio output approx. 400 c/s. Complete with instruction books and charts. **£5/19/6.** P.P. 4/6.

VALVE TESTER (by Radio City Products, U.S.A.). Model No. 314. Brand new, unused with instruction manual. 110-220 v. A.C. 50 c/s. Will test most American valves from 1.1 v. to 200 v. Price **£10/10/–.** Carriage 5/–.

AMERICAN DYNAMOTOR TYPE P.E. 103A. Heavy duty power supply. Input 6 v. @ 21 amps. or 12 v. @ 11 amps. Output 500 v. @ 16 amps. Racing continuous. Complete with connection cable and mounting rack in new and unused condition. Sealed in original crates. **£15.** Carriage extra.

ROTATABLE LOOP AERIALS (BENDIX) TYPE MN. 24 c. (motor driven). 18in. loop. New and unused. **£3/15/–.** Carriage 5/–.

R.C.A. PRE-AMPLIFIERS. Comprising 2 6J7 valves and connections. Available for photo cell input 250 v. H.T. 6.3 v. L.T. supply required. Output control. Complete unit. New and unused. **£5.** Carriage paid.

COLLINS RADIO RECEIVERS TYPE 46159A. Freq. range 1,500-12,000 kc/s. Input 12 v. or 220 v. D.C. Less crystal and power pack. This unit is part of TCS-12-Trans. Receiver equipment. In clean and good condition. Limited quantity. **£15.** Carriage 7/6.

RECORD MEGGERS. 0-500 v. 0-20 meg. with carrying case. **£8/5/–.** Post paid.

CARRIAGE CHARGES APPLY TO ENGLAND ONLY
QUOTATIONS TO THE TRADE FOR BULK SUPPLIES. ALSO ACTUAL ENQUIRIES WELCOMED. MANY OTHER LINES IN STOCK.

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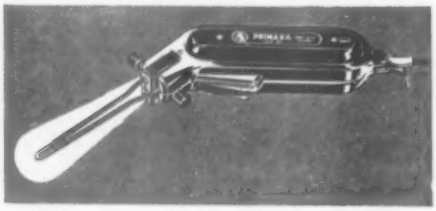
TWIN SPOTLIGHTS !!!



The new PrimaxA Soldering Gun has twin spotlights each with its own lens to light each side of the special Alloy Bit. Rated at 100 Watts this new Gun is more powerful than the Primax which has been acclaimed by Service Engineers and Amateurs. In 6 seconds the bit reaches the right temperature. You only consume current when actually soldering.

Available in 110-200/220, 220/250 v. Weight 34 ozs. Effective soldering area 1/64 sq. inch. One Year Guarantee (except on Soldering bits)

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MODEL 100 96/6

THE PRIMAX Solderer **72/6** *still as popular as before!*

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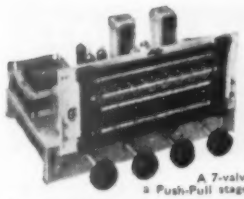
Precision Crystals of all types in a wide variety of bases covering the complete range 40 Kc. to 18 Mc. in fundamental frequencies. All are made to extremely fine tolerances and frequency adjustment can be given up to 005%. Plated electrodes of gold, silver or aluminium with wired in spot welded contacts are available. Quotations can be given for any type of cut or mode of oscillation, including a complete range for filter circuits with zero temperature co-efficient over a sensibly wide temperature range. Our new works is equipped with up-to-the-minute production technique methods, X-ray orientation ensuring accuracy of all cuts. Artificial aging by etching and plating by evaporation under vacuum ensure long term stability of the final calibration. Early delivery can be given of most types. Our regrind service is still available and in some cases we are prepared to quote for lowering the frequency of your existing crystals.

SPECIAL OFFER:

200 kc. DT cut, zero temperature coefficient over the range −20° centigrade to +55° centigrade. Frequency adjustment .005%, or better. Mode: Face shear. Silver-plated electrode, wire mounted. Basing ¼in. pin spaced. Other bases to order, **£1** each.

THREE REALLY GENUINE PRICE REDUCTIONS

A BULK PURCHASE ENABLES US TO OFFER these RECEIVER CHASSIS at SUCH LOW PRICES Each are Brand NEW and FULLY GUARANTEED



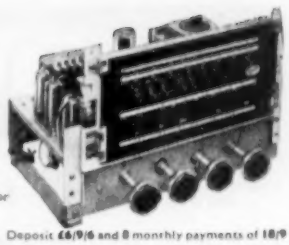
THE MODEL AW3-7

A 7-valve 3-waveband superhet chassis having a Push-Pull stage for approximately 6 watts output.

PRICE **£12/19/6**

H.P. TERMS. Deposit **£6/9/6** and 8 monthly payments of **18/9**

COMPLETE SPECIFICATION and ALL RELATIVE DATA ON THESE THREE CHASSIS IS AVAILABLE—SEND S.A.E. for the ILLUSTRATED LEAFLET.



THE MODEL B3PP

A 6-valve 3-waveband superhet with two type 6BW6 valves in Push-Pull for approximately 6 watts output.

PRICE **£12/19/6** **H.P. TERMS.** Deposit **£6/9/6** and 8 monthly payments of **18/9**

THE MODEL B3

A 5-valve 3-waveband superhet, identical in appearance to the Model B3PP illustrated above, but having a single valve (type 6BW6 output) for approximately 4 watts.

PRICE **£10/17/6** **H.P. TERMS.** Deposit **£5/18/7** and 7 monthly payments of **18/5.**

EXCEPTIONAL OFFER for CASH ONLY

This Latest B.S.R. MONARCH 3-SPEED AUTOCHANGER is offered for

£7/19/6

(NORMAL PRICE £13/10/0)

- These units will autochange on all three speeds. 7in., 10in. and 12in.
- They play MIXED 7in., 10in. and 12in. records.
- They have separate sapphire for L.P. and 78 r.p.m., which are moved into position by a single switch.
- Minimum baseboard size required 14 x 12in., with height above 5¼in., and height below baseboard 2¼in.

A bulk purchase enables us to offer these BRAND NEW UNITS at this exceptional price.

The B.S.R. Model TU.8 3-Speed Record Player

Supplied complete, including the new lightweight "Turnover" type Crystal Pick-up. **£4/12/6**

or we supply it without the Pick-up but including Turntable for **£2/18/0**

THE NEW ARMSTRONG FC48

A high-quality replacement Radio or Radiogram Chassis having provision for an FM Feeder Unit and incorporating separate BASS and TREBLE CONTROLS.

PRICE ASSEMBLED and READY FOR USE. **£25/2/0**

H.P. Terms: £12/12/0 Deposit and 12 monthly payments of £1/3/2.

The Latest Collaro R.C.54 3-Speed Autochanger

This is a "mixer" unit and incorporates the "Studio G" Crystal Pick-up. **£9/19/6**

H.P.: £5 Dep. and 7 months at 17/2.

WE ALSO HAVE IN STOCK THE MODEL 2010 PX TRANSCRIPTION RECORD PLAYER.

Stern's "Compact 5" Amplifiers

EXPRESSLY DEVELOPED FOR VERY HIGH QUALITY REPRODUCTION of GRAM. RECORDS AND PARTICULARLY SUITABLE FOR HIGH QUALITY REPRODUCTION OF THE F.M. TRANSMISSIONS: TWO MODELS ARE AVAILABLE:

The "Compact 5-3"
A 2-stage high sensitivity amplifier having SEPARATE BASS and TREBLE CONTROLS and designed to give up to approx. 5 watts with very pleasing quality. PRICE **£5/15/-**

The "Compact 3-3"
A 3-stage version of the "5-2" model, but in this case having an additional stage and incorporating negative feedback. PRICE **£6/16/-**

The Amplifiers are compact and very attractively designed, having a Bronze/Gold finish with a fully engraved front panel by which the entire Amplifier is conveniently mounted into a Cabinet, occupying no more space than a conventional Tone Control Unit. **Fully described in our Leaflets. POWER SUPPLY.** A separate small Unit is available and this in addition to supplying power to the Amplifier has additional power available for RADIO TUNING UNIT, etc. PRICE **£2/10/-.**

DESIGNS FOR THE "HOME CONSTRUCTOR"

THE COMPLETE SPECIFICATIONS OF THE FOLLOWING UNITS ARE AVAILABLE FOR 1/6 EACH.

THESE MANUALS ALSO INCLUDE THEORETICAL and PRACTICAL WIRING DIAGRAMS, AND A COMPLETE COMPONENT PRICE LIST.

The "wire-to-wire" Practical Diagrams are very simple to follow and are drawn for the "inexperienced" constructor.

- **STERN'S F.M. TUNING UNIT** . . . This is illustrated and briefly described here and can be completely built for **£10/0/0.** It is now available.
- **STERN'S COMBINED AM/FM TUNING UNIT** . . . Precisely similar in appearance to the F.M. Tuner and can be completely built for **£13/0/0.** Will be available early May.
- **THE DENCO F.M. TUNING UNIT** . . . The complete set of SPECIFIED COMPONENTS to build this can be supplied for **£7/3/9,** this includes the Denco Dial and Drive Assembly.

NOTE TO CONSTRUCTORS . . . Where desired our technical staff will, at a reasonable charge, tune and align either of the above units.

- **STERN'S "fidelity" PREAMPLIFIER . . . TONE CONTROL UNIT** . . . A design for the "Hi-Fi" enthusiast ! ! ! Briefly, it has inputs for MICROPHONES, HIGH and LOW GAIN PICK-UPS, and a RADIO TUNING UNIT. It incorporates (a) GRAM EQUALISING CONTROL (b) STEEP CUT FILTER, (c) Continuously variable BASS and TREBLE CONTROLS and a VARIABLE OUTPUT CONTROL which enables its use with any make or type of Amplifier . . . THE COMPLETE KIT OF PARTS is available now for **£6/6/0.**
- **STERN'S "fidelity" 10 WATT AMPLIFIER** . . . This design comprises the MAIN AMPLIFIER of the famous MULLARD 5-10 design and our own "fidelity" PREAMPLIFIER-TONE CONTROL UNIT which we describe briefly above. We incorporate the latest GILSEN ULTRALINEAR OUTPUT TRANSFORMER and the combination of these two units undoubtedly provides reproduction of extremely high quality, in fact the complete Amplifier is comparable to the very expensive commercially made High Fidelity models. We offer the COMPLETE KIT OF PARTS FOR **£15/15/0.** Will be available at the end of May.
- **STERN'S HIGH QUALITY 5-10 WATT AMPLIFIER** . . . This is illustrated and briefly described here. It is one of the most successful Amplifiers (in the lower price range) yet offered to the Home Constructor. We can supply the complete kit ex-stock.
- **STERN'S JUNIOR "PREAMPLIFIER-TONE CONTROL UNIT** . . . Provides full control of BASS and TREBLE in conjunction with main VOLUME CONTROL and can be used with any Amplifier. The unit contains its own POWER SUPPLY . THE COMPLETE KIT OF PARTS is available at **£3/16/9.**
- **STERN'S "PERSONAL SET" BATTERY ELIMINATORS** . . . Complete KITS OF PARTS to build Midget "Alldry" Battery Eliminators (a) Providing approx. 69 Volts at 10 m/a and 1.4 Volts at 250 m/a . . . Price **42/6** (b) Providing approx. 90 Volts at 10 m/a and 1.4 Volts at 250 m/a . . . Price **47/6.**

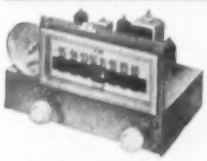
STERN'S Complete Kit for "High Quality" 8-10 Watt Design

THE IDEAL AMPLIFIER FOR GENERAL HOME USE

Price of COMPLETE KIT including Valves and Drilled Chassis, etc. **£7/10/0**

We supply it COMPLETELY BUILT for **£9/10/0**

Designed for High Quality reproduction up to an output level of 10 watts, having 6V6s in Push-Pull and incorporating negative feedback. It is suitable for use with all types of Pick-up and most types of microphone and the output transformer provides for use of 3- and 15-ohm speakers.



STERN'S "F.M." TUNING UNITS

A 5-valve Tuner incorporating the latest Mullard Permeability Tuning Heart and a "Magic Eye" Tuning Indicator. The performance of this is genuinely well up to the standard of the higher priced commercially made units and we recommend it with the utmost confidence.

THE COMBINED AM-FM TUNER is precisely similar in appearance to the above and incorporates 7 valves. It provides complete coverage of the F.M. Transmissions and the MEDIUM WAVEBAND thereby giving a good selection of foreign stations.

ALL COMPONENTS TO BUILD THESE AMPLIFIERS, TUNERS, ETC., ARE AVAILABLE FOR SALE SEPARATELY CONSTRUCTORS CAN THEREFORE GRADUALLY BUILD ANY UNIT

STERN RADIO LTD. 109 and 115 FLEET ST., LONDON, E.C.4

When Ordering Please Include 5/- Extra for Carriage and Insurance. Telephone: FLE. 5812/3/4

G.W. SMITH & CO (RADIO) LIMITED

Phone: GERRARD 8204/9155
Cables: SMITHEX LESQUARE
3-34 LISLE STREET, LONDON, W.C.2

TRADE ENQUIRIES INVITED

FOR ALL RADIO BARGAINS

WE PURCHASE ALL TYPES OF RECEIVERS AND TEST GEAR

TRANSFORMER SNIP. Admiralty pattern. Primary 230 volts 50 cycle. Three secondary windings, each 10 volt centre-tapped 5 amps. This will give any voltage between 5 and 30 volts in 5 volt steps at 5 amps. Supplied brand new. ONLY **39/6** each.

COLLINS MOD. TRANSFORMER. Push-pull 807-807. 20 watts audio. Supplied brand new only **12/6**.

AMERICAN M/C HEADPHONES. Really first quality. Impedance 20 ohms. Supplied brand new complete with ear-muffs and connector leads, **17/6** pr.

ADMIRALTY POWER UNIT 234. Input 200/250 volt 50 cycle. Output 240 volts 200 ma., 6.3 volts 6 amps. Double choke and paper condenser smoothed. Fitted with 2½in. moving iron meter reading A.C. input volts and D.C. output volts. Mounted in grey metal case for 19" rack mounting. Supplied in perfect condition, **69/6** each. Ideal for use with receivers R.1132, R.1392, R.1155.

EXTENSION DESK TELEPHONES. Can be fitted to standard switchboard. Supplied complete with handset and bell but have no dialling system. American pattern, brand new and boxed, **59/6**; English pattern **49/6**. Handsets only **12/6** each.

ROTARY CONVERTORS. Input 24 volts D.C. Output 230 volt A.C. 50 cycle 100 watts. Supplied brand new **92/6** each.

SUB-STANDARD VOLTMETERS. These portable precision instruments are supplied brand new in polished wood case. Six ranges, 0-7.5/15/30/60/150 and 300 volts D.C. 6in. mirror scale with knife edge pointer calibrated 0-150 volts. Accuracy 0.3% 68° fh. Price **£4/19/6** each.

PHOTO-ELECTRIC CELLS. Type VA.16. Brand new **8/6** each. 6 volt exciter lamps **1/6** each.

MAGNETIC COUNTERS. P.O. type. Coil res. 2300 ohms. Range 0-999. Fitted with reset mechanism **10/6** each. Ditto less reset, range 0-9999, coil 6 or 2300 ohms, **4/3** each.

FREQUENCY METERS. For 230 volt 50 cycle mains. 5in. scale calibrated 45-55 cycles. Perfect condition, **£5/10/0** each.

P.O. JACK LEADS. Brand new 6ft. screened leads fitted with two standard post office jack plugs, **3/-** each.

DEAF-AID UNITS. Still a few available. Complete, less only outside bakelite case. These contain 3 sub-miniature valves, crystal mike, tone and volume controls. Battery space on chassis (22½ and 1.5 v.). Hundreds of applications. Price only **19/6** each. Miniature earpieces to match, **3/6**. Leads 1/-. Batteries **2/9** pair.

TRANSFORMER BARGAIN. Admiralty pattern. Primary 230 volt 50 cycle. Secondary 14 volt centre-tapped at 12 amps. 100% safety rating. Brand new **42/6** each.

YAXLEY METER SWITCHES. Single pole 12 way, 8 bank, **7/6** each.

EDDYSTONE 12 VOLT POWER UNITS. Input 12 volt D.C. Output 180 volts 65 ma. Housed in grey metal case and complete with all smoothing, **19/6** each.

50 MICROAMP METERS. GRAND offer of brand new test sets containing a flush mounting 2½in. 50 microamp meter housed in grey instrument complete with chromium-plated handle. Ideal basis for sensitive test-meter, valve-voltmeter or output meter. This unit also contains a VR92 diode and many other useful components. Price **59/6** each.

BRAND NEW AMERICAN "PANORAMIC ADAPTORS." Few only in original transit cases. 200/250 volt 50 cycle A.C. mains operation. Mid-point frequency 450-470 kc/s. Sweep frequency 200 kc/s. Uses 3BP1 C.R.T. Price, only **£30** each.

SMOOTHING CHOKE BARGAINS. G.B. type. 20 henrys 175 ma. Brand new, **10/6** each. Collins type, 8 henrys 100 ma. Brand new, **8/6** each. Parmeko swinging chokes. 3.2-4.8 henrys 250 ma. Brand new, **10/6** each. Parmeko "C" core. Neptune series, 4 henry 22.5 ma. Brand new **4/6** each. 15 henry 60 ma., **5/6**; 15 henry 80 ma., **5/6**; 10 henry 40 ma., **3/6**.

PARMEKO TRANSFORMERS. Input 230 volt 50 cycle. Output 620/0/620 volts 250 m.a. tapped 550/0/550 volts and 375/0/375 volts. Two 5 volt 3 amp. windings. Ample space for 6.3 volt windings. Price **39/6** each.

RELAYS AND KEY SWITCHES. We have comprehensive stocks of all types of relays and key switches. Send us your enquiries.

METER BARGAINS.

50 microamps.	2½in. rd. F.M. M.C.	59/6
100 microamps.	2½in. rd. F.M. M.C.	39/6
500/0/500 microamps.	2½in. rd. F.M. M.C.	25/-
50 microamps.	2in. sq. F.M. M.C.	7/6
200 microamps.	2½in. rd. F.M. M.C.	9/6
1 amp.	2½in. rd. F.M. R.F.	6/9
1 amp.	2½in. rd. Pj. R.F.	5/-
4 amp.	2in. sq. F.M. R.F.	5/-
300 volts D.C.	2in. sq. F.M. M.C.	10/6
300 volts A.C.	2½in. rd. F.M. M.I.	25/-

G.E.C. STARTER RELAYS. 12 volt. Brand new **4/6**.

BATTERY CHARGER KITS. Kits contain mains transformer, rectifier, mains and L.T. switch, mains selector, necessary wire and battery clips.
6 or 12 volt 1 amp. **24/-**
6 or 12 volt 2 amp. **32/3**
6 or 12 volt 4 amp. **37/6**

A.R.88 TUNING DRIVES. Brand new and boxed, **10/6** each.

R.1294 RECEIVERS. Superheterodyne receiver covering 500/3000 mc/s. (10-60 cm.). Input impedance 70 ohms. 2 detector stages, 4 I.F. amplifier stages, 2 L.F. amplifier stages. I.F. frequency 13.5 mc/s. Bandwidth 3.5 mc/s. Price **£35** each in perfect condition. A.C. mains power packs for this receiver can be supplied at an extra cost of **52/6** each

THERMAL CUT-OUTS. Brand new Belling Lee type, 24 volt operation, **3/6** each.

18 PIN UNITERS. Brand new **3/6** pair.

AMERICAN RELAY BARGAINS.
(a) 6500 ohms, 12 v. 2 ma. **6/6**.
(b) 3500 ohms, 12 v. 6 ma. **5/6**.
(c) Double pole aerial changeover relays, 12 v. **7/6** each.

PORTABLE SUB-STANDARD MILLIAMMETERS. Manufactured by Elliott Bros. Basic movement 1 ma. Seven ranges 0/1/5/20/50/100/200/500 ma. Accuracy 0.6% 68° fh. 6in. mirror scale calibrated 0/100 ma. with knife-edged pointer. Supplied brand new with leather carrying case. **£12/10/0** each.

MINIATURE H.T. TRANSFORMER. 220/240 volt input. 200 volt 25 ma. 6.3 volt 1 amp. output, **10/6**. Midget metal rectifier to match, **7/6**.

VALVE BARGAINS.

EF80	10/6	EF91	9/6	5U4G	7/6
EBF80	11/6	PCF80	12/6	5V4G	8/6
ECF82	12/6	PCC84	12/6	5Z4G	7/6
ECC84	12/6	6SN7	6/6	6V6G	6/6
SP61	2/-				
6AG5	4/-				
VU111	1/9				
EF36	4/6				

SPECIAL OFFER GRAM MOTORS. Garrard 200/250 volt A.C. gram motors complete with turntables. Variable speed 0-45 rpm. Can be used for latest type 33 rpm. or 45 rpm. records. Absolute snip, **22/6** each.

VARIAC TRANSFORMERS. 200/240 volt A.C. 50 cycle input. Variable output 200/220 volts 7.5 amps., **£4/19/6** each.

MARCONI SIGNAL GENERATORS TFG390. 16/150 mc/s. Brand new, **£25** each. TFG.517. 16/58 mc/s and 130/260 mc/s. Brand new **£35** each.

HEAVY CHARGING TRANSFORMER. Input 230 volt 50 cycle. Output 17.5 volts 35 amp. Brand new and boxed, **72/6** each.

MARCONI CRYSTAL CALIBRATORS. Frequency coverage 170/240 mc/s. Directly calibrated, accuracy .001%. Supplied brand new in original transit case with spare set of 5 valves and 5 mc/s crystal, **£5/19/6** each.

AMERICAN PRECISION POTS. 10,000 ohms, 5½in. diameter. Built in correction plate. Brand new and boxed, **22/6** each.

AMERICAN POWER RHEOSTATS. Brand new and boxed. 8 ohm 3.3 amp., **8/6**; 8 ohm 2.5 amp., **7/6**; 90 ohm .74 amp., **7/6**; 200 ohm .35 amp., **5/6**.

METER RECTIFIERS: Miniature S.T.C. type 2 ma., fullwave and bridged, **5/6** each.

TRANSFORMER BARGAINS. All 200/250 volt input.
1. 250/0/250 volt 60 ma. 6.3 v. 3 a. 5 v. 2 a. Shrouded. **18/6**.
2. 250/0/250 volt 80 ma. 6.3 v. 4 a. 5 v. 2 a. Tapped 4 v., **18/6**.
3. 350/0/350 volt 80 ma. 6.3 v. 4 a. 5 v. 2 a. Tapped 4 v., **18/6**.
4. Tapped L.T. Trans. 3/4/5/6/8/10/12/15/18/20/24/30 volt 2 amp., **18/6**.
5. Auto Transformer. 110/200/250 volt 150 watts, **21/-**.

Filament transformers. 6.3 v. 1.5 amp., **5/9**; 6.3 v. 3 amp., **10/6**.
Admiralty types. 230 volt input.
(a) 2,000 volt 5 ma., **14/6**.
(b) 4 volt 14 amp., 6.3 volt 1.5 amp., **10/6**.
(c) 500/0/500 volt 250 ma. 4 volt C.T. 3 amp., **19/6**.
(d) 1,500 volt 330 ma., **52/6**.

H.R.O. VIBRATOR PACKS. 6 volt D.C. input. Output 165 volts 80 ma. and 6.3 volt 3 amp. Choke and Condenser smoothed, uses 6X5 rectifier, **29/6** each.

CABLE BARGAINS. Transparent twin mains flex, 2/6 dz. yds. 75/80 ohm coax, 7½d. yd. **6/6** dz. Thin twin screened, **4½d.** yd. 6 core screened cable, **1/6** yd. 7 core cable, **1/3** yd. 25 core cable, **2/-** yd. 5 amp. double insulated flex, ideal for car, **6d.** yd., **5/-** dz. Ditto 15 amp., **9d.** yd., **7/6** dz. Line-cord, .2 a. 100 ohms ft., .3 a. 60 ohms ft., **1/9** yd.

SPEAKERS. P.M. types, new and boxed. 5in. Plessey, **17/6**. 6½in. G.E.C., **17/6**. 8 in. Elac., **19/6**. 10in R.A. **27/6**. 12in. Plessey, **32/6**.

COMPONENT BARGAINS. Crystal diodes, **10d.** Dual range coil for crystal set **2/6**. 2000 mfd. 50 v. **4/6**. T.C.C. 100 mfd. 25 v. **9d.** 1000 ohm mains droppers, .2 or .3a, **3/9**. Carbon pots, all sizes w/spindle, **1/9**. With s/p switch, **3/6**, d/p switch **4/3**. Min. 465 kc. I.F's., **8/6** pr. T.R.F. coils **8/-** pr. Condensers, 1 pf.-5000 pf. **6d.**, .01 mf.-1 mf. **9d.** M/W. ferrite rods **8/9**. M/W and L/W. ferrite rods **12/9**. Ceramic condensers, all sizes, **6d.** Resistors ⅛-½ w. **3d.**, 1-2 w. **4d.** Alladin formers, ½ or ⅞in. w/slug, **6d.** Haynes formers w/can and slug, small 1/-, large **1/3**. Octal bases **6d.** B7G **6d.**, w/can, **1/3**, B9A **9d.** w/can **1/8**.

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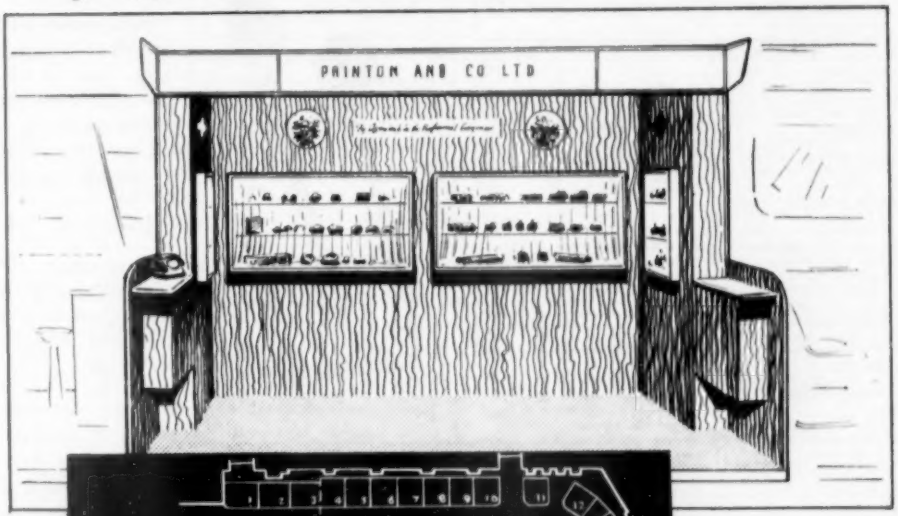
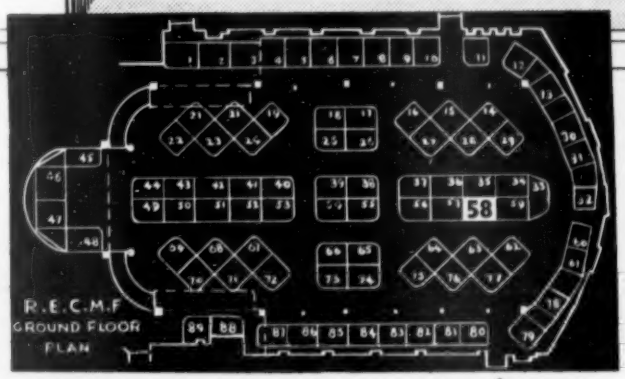
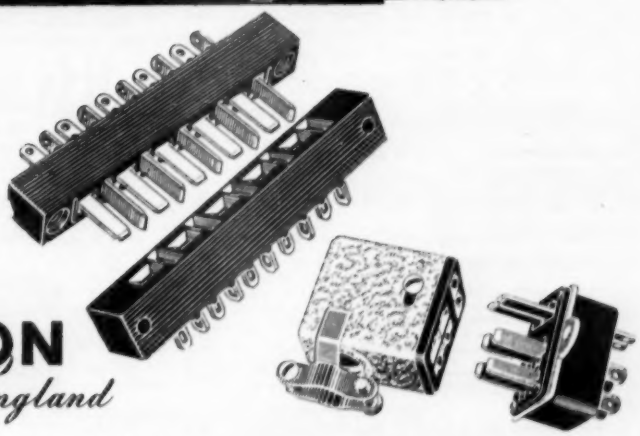




You are cordially invited to visit Stand No. 58 at this year's R.E.C.M.F. Exhibition where the complete range of Painton products will be displayed.

The illustration shows the 10-in-line and the 6 way plugs and sockets from our MULTICON ' range



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BARGAIN OFFER OF BATTERIES

4½ v. Heavy Duty Bell Battery. Size 6½ x 4½ x 2½in..... 2/6
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67½ v. Size 2¾ x 3¾ x 2¼in..... 6/6
All batteries sealed and unused. All plus 1/6 post and pkg. Special reduction for quantities.

ELECTROLYTIC CONDENSERS Per doz.
16 mfd. 375 v., 2/- each..... 21/-
24 mfd. 350 v. 1/6 each..... 15/-
24 mfd. 450 v. 2/3 each..... 24/-
Condenser Clips for above..... 3/6

BIAS CONDENSERS
1,000 mfd. 12 v. 1/6 each..... 15/-
50 mfd. 12 v. Single Hole Fixing 1/- each..... 10/6
100 mfd. 6 v. Tag End 10d. each..... 9/-
50 mfd. 50 v. 1/3 each..... 12/-

BLOCK PAPER CONDENSERS
12 mfd. 250 v. 7/6 each, 8 mfd. 600 v. 7/6 each, 4 mfd. 400 v. D.C. 3/6 each. Many other types in stock. Your enquiries invited.

MIDGET MICA CONDENSERS. .0001, .0002, .0003, .0004, .0005 5/-
200 Assorted Moulded Micas. Popular Values..... £2 10 0
200 Assorted Silver Micas. Popular Values..... £2 10 0
200 Assorted Carbon Resistors: ⅛, ¼ and 1 watt. Good selection £1 10 0

SPECIAL OFFER

0.1 mfd. 12,000 volts test Mansbridge Condensers. Height 6½in. Width 3½in. Depth 2½in. Fixing Centres 4in. Plus 1/- post. 5/6

PAXOLIN SHEET
18 x 4½ x 1/16in., 1/- each; 10 x 10 x 1/10in., 1/- each; 20 x 10 x 1/10in., 2/-.
B.T.H. CRYSTAL DIODES. 1/3 each, 12/- dozen.
RESISTORS
Carbon ½-watt 2/6; ¼ watt 3/-; 1 watt 4/-; 2 watt 6/- per doz.
WIRE WOUND AND VITREOUS. 5-watt 1/6; 10 watt 2/6; 15 watt 3/-; 20 watt 3/6 each.
HIGH STABILITY. ½ watt 5% 6d.; ½ watt 5% 9d.; 1 watt 5% 1/3 each. A few values in 1% and 2% still available.
ALL ORDERS FOR RESISTORS C.O.D. PLEASE AS WE CANNOT GUARANTEE TO STOCK ALL VALUES.
W.W.V/CONTROLS. All WELL KNOWN MAKES. Pre-set 2/6 each. Spindle types 3/- each. Many values in stock.
V/CONTROLS WITH SWITCH. 5k, 50k, ½ meg., 1 meg....each 3/6
V/Controls Less Switch. Most values spindle and preset.....each 2/-

METERS

0-300 mA. 2½in. Flush Mounting. Brand new. Guaranteed 8/6 each.
0-500 mA. 2½in. Flush Mounting. Brand new. Guaranteed 10/6 each.

4-way Push Button Units 2/6 each..... doz. 27/-
Push Button Knobs..... doz. 3/-
TAG STRIPS. 3-way 2/-; 4 way 2/6; 5 way 3/-; 7 way 4/-; 28-way..... doz. 12/-
SLEEVING. 2 mm. 2/6; 3 mm. 3/6; 4 mm. 4/6; 5 mm....per doz. yd. 5/6
POINTER KNOBS. Small black with white line, standard ¼in. spindle..... doz. 7/6
WANDER PLUGS. Red and Black..... doz. 2/-
PHILIPS TRIMMER TOOLS. 1/- each..... doz. 10/6

"S" METERS as used in S27 Receivers. Limited quantity, bargain price..... each £2 10 0

WEARITE COILS. PA4, PO4, PA5, PO5, 1/3 each..... doz. 12/-
VALVE HOLDERS. Moulded B9A 7/6; B7G 6/-; Int. Oct. 9/-; Eng. Oct..... doz. 4/6
VALVE HOLDER FITTED WITH LOWER CAN 1/6 per doz.
Extra Screening Cans for B7G and B9A..... doz. 6/-
Paxolin V/H Int. Oct. B9A, B7G 5/- per doz.; Eng. Oct., 5-pin, 7-pin..... doz. 3/-
STANDARD SCREENING CANS 3-piece 1/- each; Spring loaded ea. 1/-
BELLING-LEE PLUGS AND SOCKETS, 5-pin 1/9; 7-pin 2/-; 10-pin..... each 2/6
AIR SPACED TRIMMERS, 5, 10, 15, 20, 25, 50 and 75 pf pre-set and spindle types 2/- each..... doz. 21/-
PYE PLUGS AND SOCKETS 1/6 per pair, "Tee" pieced...each 1/9
GROMMETS. 1 grs. assorted grommets ¼in. to 1in..... gross 8/6
POST OFFICE LAMP JACKS No. 10 1/- each..... doz. 9/-
Lamp Covers for same..... doz. 3/-
BULGIN P73 3-pin plugs and sockets, and P74 2-pin plugs and sockets are now available.
OUTPUT TRANSFORMERS. Multi-ratio 5/- each; Pentode or power..... each 4/-
WESTECTORS. WX6, WX12, WI2, W4, 1/- each..... doz. 9/-
ARCOLECTRIC (Whitney Lamp), Red, Green, Clear, 1/6 each doz. 15/-
SIGNAL LAMP HOLDERS. Panel mounting, complete with adjusting lampholder, 2/- each..... doz. 21/-

BELLING-LEE. L356 fuse holders.....each 2/6

JONES PLUGS AND SOCKETS. 4-pin, 2/6; 6-pin 3/-; 8-pin 3/6; 10-pin 4/-; 12-pin..... pair 6/-

CASH WITH ORDER OR C.O.D. ALL ORDERS DEPT. W.1
ALL ORDERS FOR LESS THAN £2 ADD POSTAGE

We invite your enquiries for items not listed

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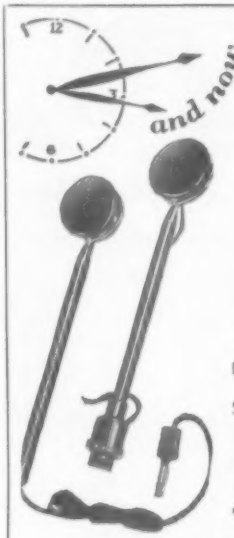

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MARK III

This magnificent bureau type cabinet is in specially selected walnut veneer exterior, with a light sycamore lining. It gives you two large-sized storage compartments
Overall dimensions:
Length 32" Height 34"
maximum depth 16"
minimum depth 11"
Motor board size: 15½" x 13"
Scale aperture size: 10½" x 14½"
NET TRADE PRICE £13.13s.0d.
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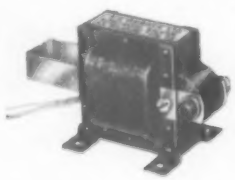

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Primary, 200-250 v. **P. & P. 2/-.**
300-0-300, 100 mA. 6 v. 3 amp., 5 v. 2 amp., **22/6.**

Semi - shrouded drop - through 300-0-300 v., 120 mA., 6.3 v. 4 amp., 5v. 2.5 amp., **22/6.**

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Chassis mounting or drop-thro'. Pri. 110-150 v. Sec. 350-0-350, 250 mA., 6.3 v. 7 amp., 6.3 v. 0.5 amp., 5 v. C.T., 0.5 amp. 4 v. 4 amp. P. & P. 3/6. **32/6.**

Chassis mounted and fully shrouded, 80 mA., 6 v. 3 amp., 5 v. 2 amp., **14/6.**

Drop thro' 270-0-270 60 mA., 6 v. 3 amp., **11/6.**

250 v. 350 mA., 6.3 v. 4 a., twice 2 v. 2 a., **19/6.**

Auto-trans. Output 200/250 H.T. 500 v., 250 mA., 6 v. 4 a., twice, 2 v. 2 a., **19/6.**

Auto-trans. Input 200/250. H.T. 350 v. 350 mA. Separate L.T. 6.3 v. 7a., 6.3 v. 1½ amp., 5 v. 3 amp., **25/-.** P. & P. 3/-.

Mains Transformer, fully impregnated. Input 210, 220, 230, 240. Sec. 350-0-350 100 mA., with separate heater transformer. Pri. 210, 220, 230, 240. Sec. 6.3 v. 2 amp., 6.3 v. 3 amp., 4 v. 6 amp. and 5 v. 2 amp., **30/-.** P. & P. 5/-.

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500-0-500 250 mA. 4 v. C.T. 4 a., 4 v. C.T. 5 a., 4 v. C.T. 4 a., **39/6.**

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R. & T.V. energised 6½in. speaker with O.P. trans. field coil. 175 ohms **9/6.** P. & P. 2/6.

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T.V. Coils, moulded former, iron-cored wound for re-winding purposes only. All-can 1½ x 1½in., **1/-** each, 2 iron-core All-can 2½ x 1¼in., **1/6** each. The above coil formers are suitable for the "Wireless World" F.M. tuner.

Used Metal Rectifier, 250 v. 150 mA., **6/6. Metal Rectifier,** 250 v. 45 mA., **6/-.**

Metal Rectifier, RM2 125 v. 100 mA., **3/6.**

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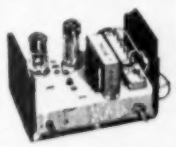
7-VALVE PUSH-PULL A.C. MAINS 200/250 v. RADIOGRAM CHASSIS

3 wave band, coverage short wave 16-50m, medium wave 187-550m, long wave 900-2,000m, 4 controls, volume control on-off, tone control, tuning and wave change with gram position. Valve line up X79, W727, two DH77's, two EL41's and EZ30. Output 7 watts. Size of chassis 16in. x 7in. x 2¼in. Size of scale 12in. x 4in. Overall height including back plate 7¼in. BRAND NEW. Fully guaranteed. P. & P. 7/6. **£9/19/6.**

T.V. CONVERTER



For the new commercial stations, complete with 2 valves. Frequency can be set to any channel within the 186-196 Mc/s band. I.F. will work into any existing T.V. receiver between 42-68 Mc/s. Input arranged for 80 ohm feeder, EF80 as RF amplifier, ECC81 as local oscillator and mixer. The gain of the first stage, R.F. amplifier 10DB. Required power supply of 200 D.C. at 25 mA., 6.3 v. A.C. at 0.6 amp. Input filter ensuring freedom from unwanted signals. Simple adjustments only, no instruments required for trimming. Will work into T.R.F. or superhet, Band Switch, and wire wound gain control. Fully screened in black crackle finished case, size 5¼in. long, 3¼in. wide, max. overall height 4¼in. **£3/19/6.** P. & P. 2/6. As above, complete with built-in power supply A.C. mains 200/250 v. **£3/19/6.** Post & Packing 2/6.

BAND III CONVERTER KIT

comprising 5 channel tuner, mains transformer, metal rectifier, electrolytic, 2 valves 12AT7 and EF80 and all necessary components for A.C. Mains operation. Complete with conversion data **£2/5/0.** P. & P. 2/6.

P.M. SPEAKER. 6½in. closed field, **18/6.** 8in. closed field **20/6.** 10in. closed field **25/-.** 3½in., **16/6.** 12in. closed field, **25/-.** P. & P. on each 2/-.

EXTENSION SPEAKER in polished walnut, complete with 8in. P.M. P. & P. 3/-. **24/6.**

B.S.R. MONARCH three speed automatic changer, current model. Brand new. Will take 7in., 10in., or 12in. records mixed. Turnover crystal head. A.C. Mains 200/250. Pre-Budget Price while stocks last. £7/15/0. P. & P. 3/-.

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Radiogram Chassis, 5 valve A.C./D.C. 3 wave-band superhet 196/255 v. 19-49, 200-550 and 1,000-2,000 metres. I.F. 470 Kc. size of chassis 13 x 6½ x 2¼in., size of scale 7½ x 3½in. Valve line-up 10C1, 10P9, 10LD11, U404 and 10P14. Twin mains filter input, 2 dial lights and 8in. P.M. **£8/17/6.** P. & P. 5/-.

SPECIAL OFFER. 8in. P.M. speakers, removed from chassis, fully guaranteed. All by famous manufacturers. P. & P. 1/6. **12/6.**

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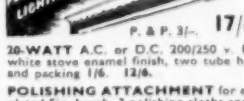
Complete kit of parts comprising accurately balanced precision made heavy turntable with rubber mat, large constant speed condenser starting motor, base plate. Can be assembled in half an hour. A.C. Mains 200/250v. Fully guaranteed. Parts sold separately. £6 - 19 - 6 Post Paid



P. & P. 3/-. **17/6**

40-WATT FLUORESCENT KIT A.C. mains 230/240. Comprising choke, power-factor condenser, 2 tube holders, starter and starter holder. No metal-work or tube.

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POLISHING ATTACHMENT for electric drills. Quarter inch spindle, chromium plated 5in. brush, 3 polishing cloths and one sheepskin mop mounted on a 3in. rubber cap. Post and pkg. 1/6. **12/6.** Spare sheepskin mops, **2/6** each.

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As above, but complete with line and frame blocking transformers, 5 Henry 25 mA. choke, 100 mfd. and 150 mfd. 250 wkg. 380 mA. A.C. ripple. **£3/9/6.** P. & P. 3/-.
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32 mfd. 350 wkg.	2/-
16 x 24, 350 wkg.	3/-
4 mfd., 200 wkg.	1/3
16 x 8 mfd., 500 wkg.	4/6
16 x 16 mfd., 500 wkg.	5/9
16 x 16 mfd., 450 wkg.	3/9
32 x 32 mfd., 350 wkg.	5/-
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250 mfd., 12 v. wkg.	1/-
16 mfd., 500 wkg., wire ends	3/3
8 mfd., 500 v. wkg., wire ends	2/6
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100 mfd., 350 wkg.	4/-
100 mfd., 450 v. wkg., 380 mA., A.C. ripple	3/11
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200 mfd., 275 wkg.	7/6
16 x 16 mfd., 350 wkg.	3/3
50 mfd., 180 wkg.	1/9
65 mfd., 220 wkg.	1/6
8 mfd., 350 wkg.	1/6
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50 mfd., 50 wkg.	1/9

Miniature wire ends moulded, 100 pf., 500 pf., and .001, each **7d.**
Combined 12in. mask and escutcheon in lightly tinted Perspex. New aspect edged in brown. Fits on front of cabinet, **12/6.** As above for 15in. tube, **17/6.**
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250 mA., 10 henry, **10/6**; 5 henry 250 mA. 60 ohms, **8/6.**
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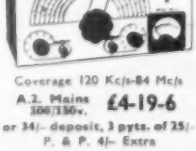

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P. & P. 4/- Extra

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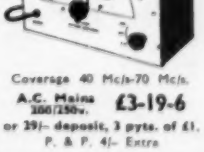

Coverage 40 Mc/s-70 Mc/s.

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12in. × 6in. × 2½in.	8/6	14in. × 10in. × 2½in.	11/-
12in. × 8in. × 2½in.	9/6	17in. × 10in. × 2½in.	12/6

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14in. × 10in. × 2½in.	10/3	17in. × 10½in. × 3in.	12/6

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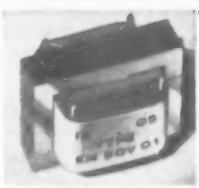

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For Cathode Ray Tubes having Heater/Cathode short circuit or for C.R. Tubes with failing emission.
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2 volt	10/6 each	With Tag
4 volt	10/6 each	Panel and
6.3 volt	10/6 each	Solder Tags
12.6 volt	10/6 each	
13.3 volt	10/6 each	

Ditto with mains primaries 12/6 each.
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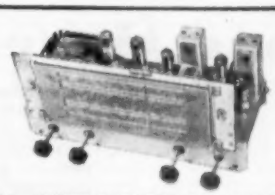

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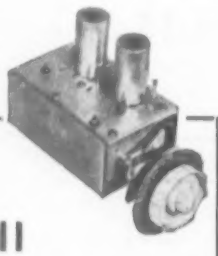

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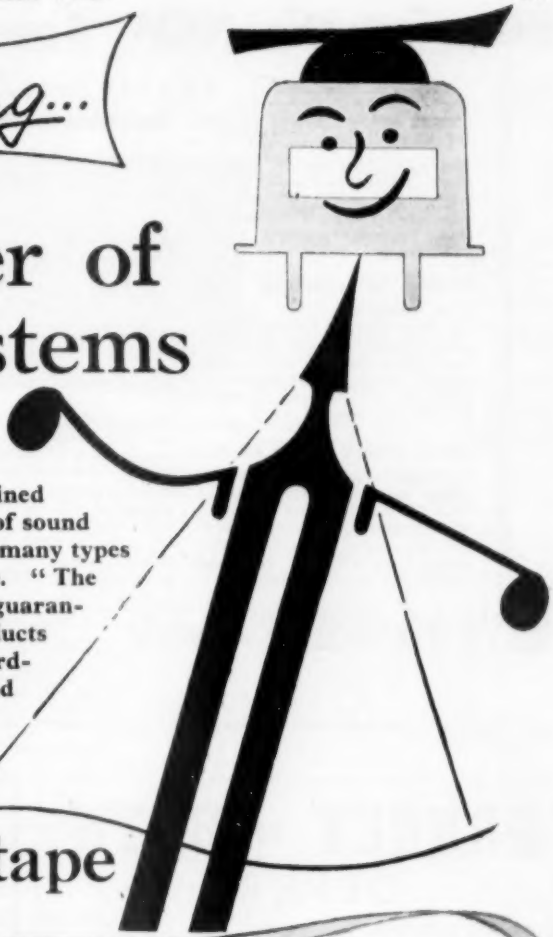

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150 Milliamp.	D.C. M/C	2in.	Flush square	7/6
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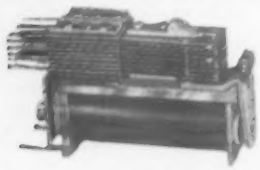

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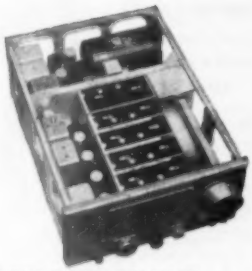

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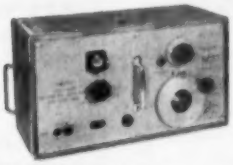

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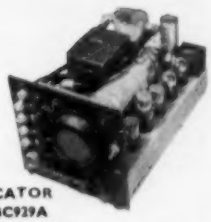

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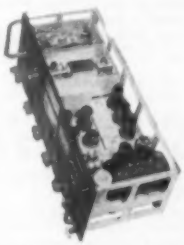

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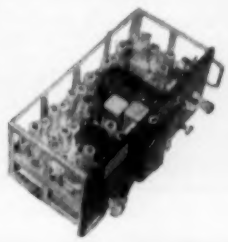

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SAMSON'S SURPLUS STORES

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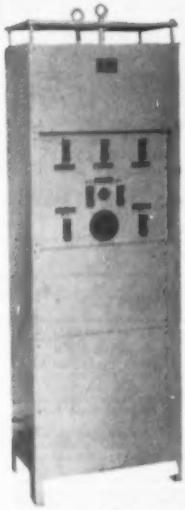

S.T.C. RECTIFIER SUPPLY UNIT No. 11 TYPE ZB 10235

Specification:—A.C. input 100-260 volts. 45-65 cycles. D.C. output 24 volts 11 amps. and 130 volts 600 m.a. very conservatively rated. L.T. and H.T. completely smoothed. All circuits fused. Mains on/off switch. Built in grey metal cabinet as illustrated. Height 5ft. 0in., width 1ft. 7½in., depth 1ft 1½in Weight 200 lbs

These units were originally designed to supply L.T. and H.T. power in conjunction with Bay Power No. 3 to S.O.S./T. 3 channel telephone system, but are ideal heavy duty L.T. and H.T. supply units for the electronic industry, research laboratories, schools, etc., etc. Complete with Instruction Book and circuit. Supplied brand new at a fraction of the maker's price.

£17.10.0 ex-warehouse

If further technical details are required, Instruction Book will be forwarded against a deposit of One Pound. Export enquiries are welcomed. We have a limited number of these units ready packed in original transit cases at a small extra charge.

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INTRODUCING THE "VISCOUNT" tape recorder, successor to the "Herga" and making FULL use of the Push-button facilities of the wonderful new Motek K8 deck, Servo brakes, Button control of Amplifier, roller, pads & brakes. Adjustable Azimuth and possibility of changing from B. S. I. to Continental Standard. But write for leaflet and judge whether this is not the best value in recorders at 42 Guineas, or £22/2/- down and 12 monthly payments of £2/3/1, or 8 months' Credit terms in certain cases.

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Sounds incredible, but it is GUARANTEED.
Send for copy of N.P.L. report and see our ad. in April issue of "W.W." The HATFIELD oscillator is now made with 3 output impedances to suit any Head on the market. 45 Kc/s to 50 Kc/s.

TAPE RECORDISTS! Are you **Completely** satisfied with your recordings? Bad waveform in an oscillator can cause DISTORTION due to intermodulation, NOISY BACKGROUND due to D.C. component in an asymmetrical waveform and INTERFERENCE with radio due to harmonics beating with incoming signal. The fundamental cannot do this!
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Even a small amount of bias frequency getting into the amplifier can cause a lot of trouble, and nearly all tape recorders need a rejector coil to prevent this.
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The famous K8 deck; twin track, two speed, with push buttons and SERVO braking, is a beautifully finished job at only **£19/19/-**. Post free. Or H.P. terms on application.

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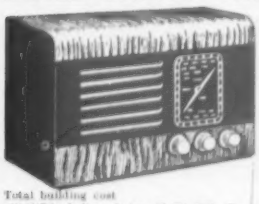

Total building cost £5/7/6 including choice of beautiful walnut veneered cabinet or ivory or brown bakelite. **This is the lowest possible price consistent with high quality. No radio knowledge whatever needed . . . can be built by anyone in 8-9 hours,** using our very simple, easy-to-follow diagrams. This terrific new circuit covers all Medium and Long Waves with optional negative feedback, has razor-edge selectivity, and exceptionally good tone. Price also includes ready drilled and punched chassis, set of simple, easy-to-follow plans—in fact, everything! All parts sparkling brand-new—no junk! **Every single part tested before despatching.** Uses standard octal-base valves: 6K7G high-frequency pentode feeding into 6Q7G anode-bend detector triode, coupled to 6V6G powerful output beam-power tetrode, fed by robust rectifier. For A.C. Mains, 200-250 Volts (low running costs—approximately 18 Watts). Size 12in. × 6in. × 8in. Send £5/7/6 for all parts and set of plans. (Add 3/6 for packing and post. C.O.D. 1/6 extra.) Priced Parts lists 2/-.

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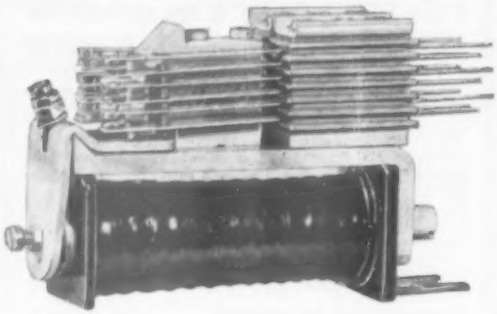

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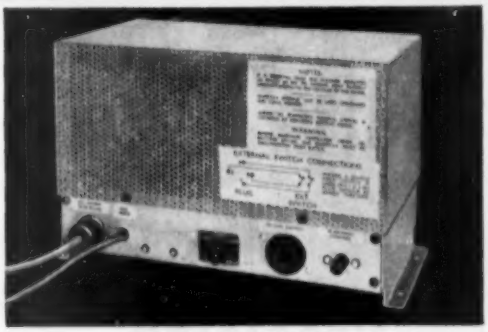

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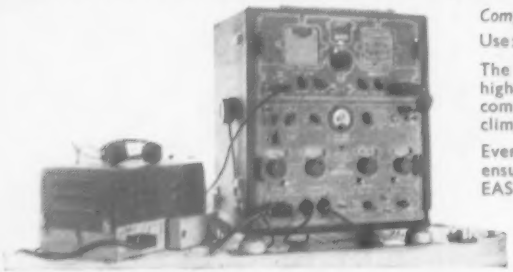

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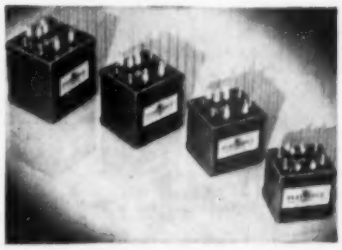

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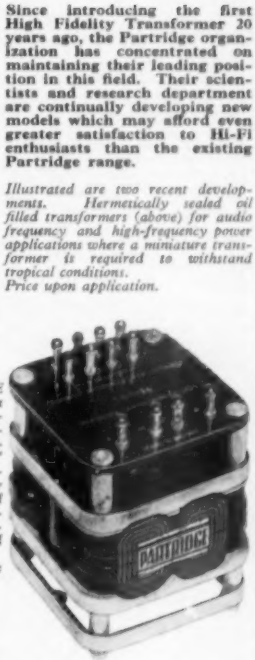

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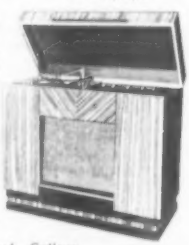

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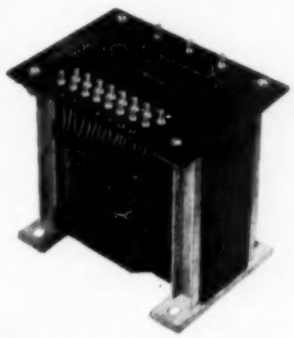

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FALKLAND Islands Dependencies Survey for service in the Antarctic for 30 months under conditions which are a test of character and resource. Commencing salary according to age in scale £400 rising to £540 a year with all found including clothing and canteen stores. Liberal leave on full salary. Candidates, preferably single and aged 21-28 years, must be of good education and high physical standard and have a real enthusiasm for hard work under trying conditions. They should have a sound knowledge of physics and radio maintenance and preferably hold a physics degree. Selected candidates will undergo three months' training in the U.K. before departure. Write to the Crown Agents, 4, Millbank, London, S.W.1. State age, name in block letters, full qualifications and experience and quote M3B/45201/WF. [5841

RADIO Officers required by

EAST Africa High Commission Directorate Civil Aviation for one tour 30 to 36 months in first instance with prospect of permanency. Salary scale (including Inducement Pay and present 10% temporary allowance) £772 rising to £1,122 a year. Commencing salary according to experience. Good prospect promotion to Radio Superintendent. Salary scale including Inducement Pay and 10% allowance rising to £1,290 a year). Free passages. Liberal leave on full salary. Outfit allowance £30. Candidates must be capable operating at 25 w.p.m. and should hold M.T.C.A. 1st Class Flight Radio Operator's licence or P.M.G. 1st Class Cert. Proficiency or Communicator (M.T.C.A. or equiv.) Knowledge of touch typing for teleprinter an advantage. Write to the Crown Agents, 4, Millbank, London, S.W.1. State age, name in block letters, full qualifications and experience and quote M2C/41556/WF. [5817

RADIO engineer required for

SOCIAL development department, Tanganyika, on contract for tour of 30-36 months in first instance; salary scales (including inducement pay and present temporary allowance of 10% of salary) £898 rising to £1,782 and £1,003 rising to £1,498 a year according to qualifications; gratuity at rate of 13½% of total substantive salary drawn; outfit allowance £45; free passages; liberal leave on full salary; candidates, preferably under 35 and possessing a degree or similar qualification, should have experience of high-power transmitting equipment and be able to take charge of 20KW, 1.25KW and 250 watt R.C.A. transmitters at Broadcasting Station.—Write to the Crown Agents, 4, Millbank, London, S.W.1. State age, name in block letters, full qualifications and experience and quote M2C/41312/WF. [5866

SENIOR Design Draughtsmen.

SENIOR design draughtsmen are required for a new Research laboratory of a long-established engineering company being set up in Romsey, Hampshire. The work of the laboratory consists of fundamental studies in various branches of electronics, and draughtsmen are required to work on the design of pre-prototype models and associated test equipment. These posts, which are permanent and progressive, call for men of high-class ability. Salary range from £700 to £950 per annum.—Please reply, giving full details of qualifications and experience, to the Personnel Manager, The Plessey Company, Limited, Vicarage Lane, Ilford, Essex. [5854

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SITUATIONS VACANT

RADIO Technician required by CYPRUS Government for service as CHIEF Inspector of Police (Communications Mechanic) on contract for tour of four years in first instance. Salary according to experience in scale (including Overseas Allowance and present temporary allowance of 9% of salary):—£967 rising to £1,096 a year. Gratuity at rate of £100 a year. Free passages. Liberal leave on full salary. Candidates of good education must have thorough knowledge maintenance of low-powered VHF equipment, fixed and mobile, petrol driven alternators, etc. and good background workshop experience. Write to the Crown Agents, 4, Millbank, London, S.W.1. State age, name in block letters, full qualifications and experience and quote M1/57835/WF. [5628

FERRY AIRPORTS, LIMITED.

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SOUTH Eastern Division.
4TH Assistant Engineer (Electronics) required in the Operation Department at Kingston for original development work as applied to Power Station operation; preference given to those suitably qualified and with previous experience in the design and construction of electronic circuitry; knowledge of Power Station operation an advantage but not essential; salary according to qualifications and experience within the range of £630–£824 5s per annum including London Allowance in accordance with Class X/DX Grade 6.—Detailed written applications should be sent to the Establishments Office, Central Electricity House, Lower Ham Rd., Kingston, to arrive by May 4, 1956. [5881

ASSISTANT Signals Officer required by SIERRA Leone Government Civil Aviation for two tours each of 18/24 months. Appointment will be either (a) on contract with salary scale (including Expatriation Pay) £859 rising to £1,359 with gratuity up to £150 a year or (b) with prospect of pensionable employment with salary scale (including Expatriation Pay) £797 rising to £1,257 a year. Outfit allowance £60. Liberal leave on full salary. Free passages for officer and wife. Assistance towards cost children's passages or grant up to £150 annually for maintenance in U.K. Candidates should be experienced MF, HF, VHF, VHF/DF and ancillary equipment and should hold P.M.G. Cert. or equiv. Preference for C. & G. Cert. in Radio. Write to the Crown Agents, 4, Millbank, London, S.W.1. State age, name in block letters, full qualifications and experience and quote M2C/41565/WF. [5652

HUDDERSFIELD TECHNICAL COLLEGE.

PRINCIPAL: Dr. W. E. Scott, M.B.E.
DEPARTMENT of Electrical Engineering.
REQUIRED as soon as possible, Assistant Grade A to teach particularly in the radio and television servicing courses. Candidates should possess the City and Guilds of London Institute R.T.E.B. Certificates in both radio and television servicing and have had industrial experience. Teaching experience an advantage. BURNHAM scale, at present £450×£18—£725 p.a. plus appropriate allowances for training, etc.
FURTHER particulars and forms of application which must be returned as soon as possible, obtainable from the Principal, Technical College, Queen Street South, Huddersfield.
H. GRAY,
CHIEF Education Officer.
26TH JANUARY, 1956. [5706

WIRELESS Operator Mechanics required by FALKLAND Islands Dependencies Survey for service at isolated British bases in Antarctic. Must be able transmit and receive morse at 20 words a minute (plain language or code) and be capable elementary maintenance wireless transmitting and receiving equipment. Salary according age in scale £330 rising to £420 a year with all found, including clothing and canteen stores. Keen young men between 20 and 30 years required preferably single, of good education and high physical standard with genuine interest in polar research and travel willing to spend 30 months under conditions testing character and resource. Write to the Crown Agents, 4, Millbank, London, S.W.1. State age, name in block letters, full qualifications and experience and quote M2C/41540/WF. [5627

IBM United Kingdom, Ltd., Spango Valley, Greenock.
ENGINEERS and Technicians with electrical, electronic or mechanical qualifications and experience required by the Technical Department to assist in the development and production of accounting machines, electronic computers, etc.; the work is interesting and offers permanent progressive employment in pleasant surroundings.—Applications should be made in writing stating age, experience, etc., to the Personnel Manager. [5872

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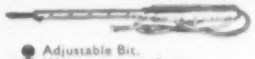

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SALARY (at age 26+) £520, rising to £630.
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PYE TELECOMMUNICATIONS, Ltd., Ditton Works, Cambridge.
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APPLICATIONS are invited for the post of research assistant in the department of electrical engineering for investigational work in connection with network analysers.
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(c) POSSESSION of an aircraft radio maintenance engineer's licence.
(d) EXPERIENCE in the design, construction or maintenance of electronic computors.
COMMENCING salary will depend upon qualifications, but will be within the range £13/10/6 to £15/15/6.
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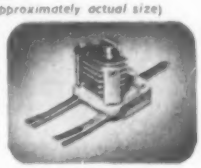

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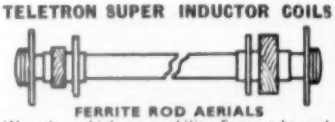

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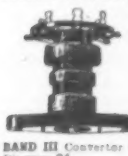

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CANDIDATES must produce evidence of having reached a prescribed standard of education, particularly in a science or mathematical subject. At least two years' experience in the duties of the class gained by service in a Government Department or other civilian scientific establishment or in technical branches of the Forces essential in one of the following groups of scientific subjects:—

(i) ENGINEERING and physical sciences.
(ii) CHEMISTRY, bio-chemistry and metallurgy.
(iii) BIOLOGICAL Sciences.
(iv) GENERAL (including geology, meteorology, general work ranging over two or more groups (i) to (iii) and highly skilled work in laboratory crafts such as glass-blowing).

INCLUSIVE salary scale £290 (at 18) to £575 (men) or £502 (women). Starting pay up to £423 (men) or £385 (women) at 25. Women's pay subject to improvement under Equal Pay scheme. Somewhat less in provinces. Opportunities for promotion.

FURTHER particulars from Civil Service Commission, Scientific Branch, 30, Old Burlington Street, London, W.1, quoting No. 859/56. Completed applications should be returned as soon as possible and in any case not later than 31st December, 1956. [5692

ATOMIC ENERGY RESEARCH ESTABLISHMENT, Harwell, invites applications for the following posts in its Electronics Division.

REF. 519. Senior Scientific Officer to direct fundamental research into electronic circuit techniques with special reference to transistors and magnetic devices. Expected to supply original ideas and within wide limits free to choose line of research. Some post-graduate research experience is essential.

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APPLICANTS for both posts should possess a 1st or 2nd class Honours Degree in Science (or equivalent).

SALARY Scales.
SENIOR Scientific Officer: £1,105-£1,270.
SCIENTIFIC Officer: £528-£948.
CONTRIBUTORY pension scheme, five-day week; excellent working conditions and generous leave allowances.

MARRIED officers living outside the Establishment's transport area will be eligible for housing under Authority arrangements or, alternatively, substantial assistance towards legal expenses incurred in house purchase will be available.

SEND postcard for application form to Establishment Officer, A.E.R.E., Harwell, Didcot, Berks, quoting appropriate reference. [5857A

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(1) DESIGN engineers to assist in the development of a wide range of precision laboratory equipment. Applicants should have previous design experience, education to H.N.C. or degree standard preferred.

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THE above appointments are permanent and carry considerable technical responsibility, salaries are dependent upon age, qualifications and experience.—Apply stating full details to Chief Engineer, Furzehill Laboratories, Ltd., 57, Clarendon Road, Watford, Herts. [5765

PHILIPS ELECTRICAL INDUSTRIES, Ltd., have vacancies for two assistant engineers in their Central Standardisation Department at Waddon, Surrey.

ONE of these should be a man possessing experience of development or production in the radio or allied industries and whose duties would comprise standardisation work in connection with telecommunications and electronic apparatus, materials and components. The other should possess drawing or design office experience, not necessarily in the electrical industry, and would be required to undertake standardisation work in basic engineering subjects such as drawing office practice.

THESE posts are permanent and pensionable and appropriate and progressive salaries will be paid.

MEN who are H.N.C. level of education and are interested in this type of work as applied in a large manufacturing organisation are invited to write in confidence to the Personnel Officer, Philips Electrical Industries, Ltd., New Rd., Mitcham Junction, Surrey. Quoting reference.—P./2. [5806

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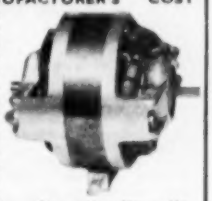

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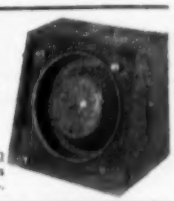

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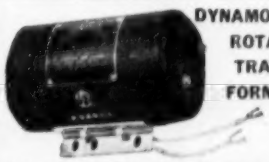

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ELECTRONIC Test Engineers are required by The General Electric Co., Ltd. Radio and Television Works, Spon St., Coventry, in the Departments concerned with:—
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(b) TESTING of Government contracts production and other electronic equipment.
(c) DEVELOPMENT, manufacture and maintenance of test equipment.
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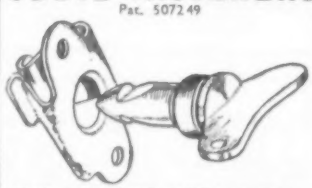

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PHYSICIST, wide experience of electronic devices and circuits design; applicants should be capable of leading a development team; salary from £900, according to qualifications; age 26-36.—Apply, Employment Manager, Southern Instruments, Ltd., Frimley Rd., Camberley, Surrey. [5751

TELEVISION Maintenance Engineers for studio telecine and control apparatus. Engineers with knowledge of television techniques and circuitry and possessing initiative required.—Applications to Assistant General Manager (Staff), Associated-Rediffusion, Ltd., Kingsway W.C.2, marking the envelope (A.M.E.). [5850

INTERESTING and congenial position in London retail business of good standing; good English typing and figure work essential; applicant must have high standards of service; opportunity for well secured investment if desired; state age and details of career.—Box 1023. [5868

ENGINEERS with experience of radio and television are required for development work in the design department of a firm situated some 10 miles south-west London at salaries of £700 to £1,200 p.a.—Write giving particulars of qualifications, experience and salary required to Box 6867. [5647

JUNIOR Technical Assistant required by London Chartered Patent Agents with a view to training for qualifying as a Patent Agent. Degree standard in electrical engineering desirable.—Write giving details of age, experience, etc., to Box No. 3140, c/o White's, Ltd., 72/78, Fleet St., London, E.C.4. [5792

ELECTRONIC engineers and physicists reqd. for rapidly expanding research dept. Candidates should have experience of electronic instrument development. Experience in pulse circuits or ultrasonics desirable but not essential. B.Sc. or H.N.C. standard.—Write full parties. to Glass Developments, Ltd., Brixton. [5596

ENGINEER required to undertake complete design and testing of disc and tape recording equipment. Applicants should have had responsible experience in this field. Excellent working conditions and facilities provided in new laboratory.—Applications with details of previous experience should be sent to Box 0563. [5785

TEST Engineers required for a wide variety of modern electronic test equipment; an ability to quickly master details and to work with minimum supervision are essential qualifications. This can become a staff position for suitable applicants apply—The Wayne Kerr Engineering Co., Ltd., Tolworth Close, Surbiton, Surrey. [5758

LABORATORY Assistant for operation, mtce., and develop., of electrical apparatus for high temp. studies of clays; knowledge of elec. installs., practice desirable; male ex. Nat. Ser. pref.; sal. age 20, £300; age 25, £400 (max. on entry) to £550.—Apply to The Secretary, Rothamsted Experimental Station, Harpenden, Herts. [5810

FERRANTI, Ltd., require charge hands in electronic test and test gear maintenance departments of their radar valve factory; H.N.C. in electrical engineering desirable, and experience of microwave equipment and radar circuits essential.—Apply in writing to the Personnel Supervisor, Ferranti, Ltd., King's Cross Rd., Dundee. [5856

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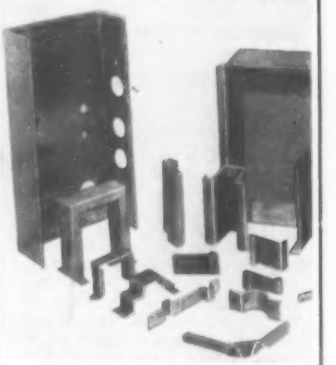

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TECHNICAL sales representative required to initiate sales programme for new electronic product; general radio background desirable, with sales experience in this field.—Write, giving full details of past experience and salary required, to Personnel Officer, British Communications Corporation, Ltd., Exhibition Grounds, Wembley. [5755

SENIOR and Junior Electrical and Mechanical Draughtsmen required for the Electronics Drawing Office of the British Thomson-Houston Co., Ltd., Blackbird Rd., Leicester.—Please apply in writing to Chief Draughtsman, Electronics Drawing Office, British Thomson-Houston Co., Ltd., Rugby, giving details of age, experience, etc. [5645

TWO radio and T.V. engineers, H.N.C. Graduate I.E.E. or Brit. I.R.E. or equivalent; age about 25; for duties as Liaison Engineers between regional works and field; duties will involve some travelling and field investigation; based at (1) Stockport, (2) Nottingham; salary £700-£800, according to ability.—Box 0817. [5645

ELECTRONIC Design Draughtsman required for work on electronic instruments and electromedical apparatus. H.N.C. or equivalent desirable. Age 25-35 years. Salary £700-£800 per annum, according to qualifications.—Please apply to the Personnel Officer, The Edison Swan Electric Co., Ltd., Duck Lees Lane, Ponders End, Middx. [5794

UNIVERSITY OF SOUTHAMPTON.—Technician required to work on electronic equipment in the Mechanical Engineering Department; salary in the technical grade, according to qualifications; superannuation and sick pay schemes in operation.—Applications, in writing, to Secretary and Registrar, The University of Southampton, as soon as possible. [5674

ELECTRONICS Technician required for the construction and maintenance of electronic apparatus for medical teaching and research; age 25 to 35. Salary according to age and experience with superannuation.—Apply in writing, stating age and giving details of experience to the Secretary, Guy's Hospital Medical School, London Bridge, S.E.1. (Reference 29.) [5845

TELEVISION, radar and radio technicians are required by a leading Midlands manufacturer for the test department. First-class men with experience of testing and fault-finding in the electronic field will find these posts interesting and rewarding.—Write, quoting Ref. TRR, and giving brief details of career to date to the Personnel Manager, Box No. 8580. [5595

THE TELEGRAPH CONDENSER Co., Ltd., require radio and T.V. engineer with laboratory experience for the application of printed circuits to radio and television techniques. H.N.C. standard; superannuation scheme.—Write, giving full details of education and experience, age and salary required, to Personnel Manager, T.C.C., Ltd., North Acton, W.3. [5755

ELECTRONIC technician, senior laboratory technician—department of physics; maintain, repair, construct electronic and other equipment; salary about £1,000 year, rent subsidy and hospitalization plan, travel and moving expenses, one month vacation, pleasant climate, university atmosphere.—Applicants write to Chairman, Dept. of Physics, American University of Beirut, Beirut, Lebanon. [5859

TECHNICAL assistants required for research and development in telecommunications and other electronic equipment.—O.N.C. or H.N.C. an advantage; also, B.Sc. graduates or potential graduates are invited to apply; pensionable appointments.—Write giving full details of experience and salary required to British Communications Corporation, Ltd., Exhibition Grounds, Wembley. [5858

SALES manager required by a rapidly expanding company in Glasgow manufacturing low-power transformers and electronic devices; salary according to age and experience in the industry; a pension scheme is in operation, and a car is provided for candidate's sole use.—Full details, in writing in the first instance, to Atkins, Robertson & Whiteford, Ltd., 100, Torrisdale Street, Glasgow, S.2. [5815

ELECTRONIC engineer for design, construction and use of electronic equipment in connection with experimental work in the motor car industry. Some previous industrial experience and H.N.C. or its equivalent is necessary.—For further information or interview please write with full particulars to the Labour Manager, The Rover Co., Ltd., Lode Lane, Solihull, Warwickshire. [5754

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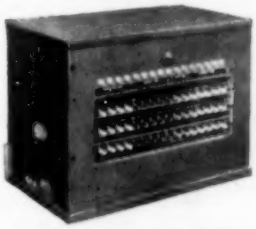

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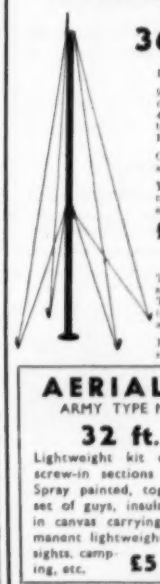

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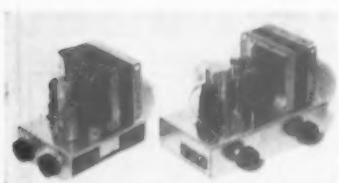

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ELECTRO-ACOUSTICS ENGINEER required by Post Office Contractor in S.E. London area for audio frequency laboratory measurement work on line communication equipment; preferably aged 25-35 years with a degree or equivalent, but younger man just qualifying or older man with suitable background would be considered.
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ELECTRONICS Technician required by Physics Department, University of Leeds, for development and constructional work on equipment for research and teaching; initial salary in the range £580-£545 according to qualifications and experience.—Apply, giving references and synopsis of career to the Secretary, Department of Physics, The University, Leeds, 2. Closing date 19th May. [5875

AERODYNAMICIST required for our London office; candidates should be 24-28 years of age, with a good degree and some experience of supersonics; duties will be of a varied nature, including thermodynamic work and liaison with trials teams.—Please write in detail, quoting Ref. 118, to The Personnel Manager (Technical Employment), de Havilland Propellers, Ltd., Hatfield, Herts. [5623

SHIFT chemists (male) required for routine control of production processes in the capacitor field; preliminary period of training will be given, but applicants must be of either Inter. B.Sc. or G.C.E. (Advanced) standard, preferably with analytical experience.—Applications in person or in writing should be made to The Personnel Manager, The Plessey Co., Kembrey St., Swindon, Wiltshire. [5725

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ELECTRICAL development engineer required with technical and practical experience of all branches of electrics applicable to aircraft; must be willing to accept full responsibility and be qualified to carry out an extensive programme of test work and analysis of results; a commensurate salary will be paid.—Full particulars in writing to the Chief Engineer, The Fairey Aviation Co., Ltd., Hayes, Middlesex. [5736

MECHANICAL development engineer required for design and development of instruments and light servo mechanisms; qualifications include Degree or H.N.C. in mechanical engineering; experience of film cameras, small servo-mechanisms, etc.; salary £600-£1,000, according to experience and qualifications.—Apply, Employment Manager, Southern Instruments, Ltd., Frimley Rd., Camberley, Surrey. [5752

SENIOR telecommunication engineer required for development of submarine repeaters, applicants should have several years experience in carrier telephony practice, e.g., in the design of filters and feed-back amplifiers; technical education: Honours degree in electrical engineering or equivalent qualifications; post is eligible for pension scheme, five-day week; applicants should give details of age, previous experience and salary required to PERSONNEL Manager, Telcon Works, Greenwich, S.E.10. [5885

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ELECTRICAL (electronic) development engineer required, age 25/30 years; minimum qualification H.N.C. or C. & G. certificates; permanent pensionable appointment after trial period; based in City of London; please write in strict confidence, giving full particulars of education and experience to date, stating age and commencing salary expected; no other similar staff employed or contemplated.—Box A.660, c/o Central News, Ltd., 15, London Wall, E.C.2 [5801

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SITUATIONS VACANT

DEVELOPMENT Engineers and Technical Assistants required by expanding company in High Wycombe, in connection with industrial electronic control and the development of communication and electronic test equipment; positions are available at all levels in the salary range £450 to £1,200; commencing salary according to qualifications and experience; these are permanent staff appointments.—Apply Personnel Officer, Airmec, Limited, High Wycombe, Bucks. [5776

THE Plessey Company require Sales Engineers, for technical liaison work with Radio, Television and Electronic Equipment manufacturers; knowledge of radio and television circuitry and ability to discuss them with engineers is essential; applications are invited from engineers resident in both the London and Midland areas.—Write, stating age, qualifications, experience and salary required to the Personnel Manager, The Plessey Co., Ltd., Kembrey St., Swindon, Wilts. [5807

ELECTRONIC Engineers.—A leading company in the guided weapon industry offers careers as technical representatives to engineers with industrial and service experience; comprehensive training will be given for these progressive appointments which carry expense allowances.—Details of age, education and experience, in confidence, quoting Ref. 120, to The Personnel Manager (Technical Employment), de Havilland Propellers, Ltd., Hatfield, Herts. [5815

WIREMAN.—There are a number of positions available within a Guided Weapon organization for all grades of wiremen, one post in particular calls for a man able to work on his own initiative, interpreting rough sketches and verbal instructions into finished models; some design and testing knowledge is required; prospects for experienced men of high standard are excellent.—Please write in detail, quoting Ref. 75, to the Personnel Manager (Technical Employment), de Havilland Propellers, Ltd., Hatfield, Herts. [5711

AERONAUTICAL INSPECTION SERVICE: Radar and Wireless Divisions.—Vacancies exist for Examiners (unestablished) at Stafford, Stockport and Henlow; City and Guilds Intermediate group certificate in telecommunications engineering (or equivalent theoretical knowledge) required with experience in industry or services; salary range £565—£695 (men); prospects of promotion and establishment; no age limits.—Details and forms from Air Ministry S.2(q), Cornwall House (W.W.), Stamford St., London, S.E.1. [5855

MAKERS of T.C.C. Condensers, N. Acton, London, invite applications for the positions of Technical Sales Representatives. The situations offer good prospects and are pensionable. Applications, containing details as to age, qualifications, experience and salary required, will be considered in strict confidence. Only first-class men are being entertained—preferably those with experience in the radio and electrical industries.—Reply to Sales Director, The Telegraph Condenser Co., Ltd., North Acton, London, W.3. [5859a

THE GENERAL ELECTRIC Co., Ltd., Brown's Lane, Allesley, Coventry, requires mechanical development engineers, designer draughtsmen and draughtsmen, preferably with experience of radar-type equipments, for work on guided weapons and like projects; also required, senior and junior electronic development engineers, particularly in the field of microwave and pulse applications; salary according to age, qualifications and experience. Apply by letter, stating age and experience, to the Personnel Manager, Ref. R.G. [0259

TELEVISION Development. Applications are invited for the posts of development engineers in the laboratories of a leading television manufacturer. Qualified men with experience of, or an interest in, the latest techniques in this field, including colour television, will find considerable scope in these positions, which have been created by expansion of existing departments.—Applicants should write, in confidence, giving brief details of past experience to the Personnel Manager (Ref. T.D.), Box 8408. [5576

SENIOR Technical Assistant required to deal with technical correspondence and business matters concerning sub-contracts and liaison with outside firms; must be technically competent, preferably with experience of electronics, and accustomed to working from drawings; this is a senior staff position and applicants must be over 25 years of age.—Please write, giving full details of age, qualifications and past experience, quoting Ref. 79, to the Personnel Manager (Technical Employment), de Havilland Propellers, Ltd., Hatfield, Herts. [5712

RAINBOW RADIO MFG. Co., Ltd., of Mincing Lane, Blackburn, Lancs, require the services of a young man, as personal assistant to our technical director; applicant must be one with drive and initiative, experienced in up to the minute radio and television technique, and capable of accepting responsibility; the position is permanent and offers excellent opportunities in a well established and progressive company; commencing salary £650, rising to four figures within a reasonable time to the right man.
WRITE, stating age, qualifications (if any) and background of experience.—Attention C. O. Clark, Technical Director. [5864

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require a young engineer up to 30 years of age with good technical qualification in physics, electrical engineering or radio to join the Radio Division as Technical Commercial Assistant. Duties will cover preparation of publicity material, some technical articles and reports and entail liaison work between design engineering, production and commercial departments. A knowledge of overseas market requirements would be an additional qualification. Applications in writing should be addressed to Personnel Officer, Century House, Shaftesbury Ave., London, W.C.2, quoting reference No. 802.

COMMERCIAL T.V.

Commercial Television and F.M. broadcasting have resulted in vacancies becoming available for men interested in the development of V.H.F. tuners involving new techniques of design and manufacture. Salaries in the range of £650-£1,200 are offered to Engineers with the required experience, and prospects of future advancements are good. Write, in confidence, giving full particulars of experience and qualifications to Box No. 784.

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How to Make Aerials for T.V. Bands I and III, and V.H.F. Bands II, 10 different designs. Postage 4d.	2/6
The A.R.R.L. Handbook 1956 edition. Postage 1/3	30/-
Magnetic Recording Handbook, by Hickman. Postage 1/-	21/-
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SITUATIONS VACANT

A TELE-COMMUNICATIONS organization of international repute has vacancies in the London area for electrical engineers on the development of a wide range of high frequency testing equipment associated with the design of telephone and television cables; applicants should have a degree or equivalent, with practical experience in electronics; well-equipped laboratory with access to all facilities of a large organization; permanent, pensionable position with commencing salary range £750 to £850.—Write, stating experience, qualifications, age, to Box 0819. [5842

MINISTRY OF SUPPLY, London, requires experimental officer for security classification of research and development reports and other technical security work concerned with aircraft and electronics; qualifications—Higher School Certificate (Science) or equivalent; broad engineering knowledge, preferably with experience in the electronic field, required; minimum age 26; salary within range £790-£960.—Application forms from M.L.N.S., Technical and Scientific Register (K), 26, King St., London, S.W.1, quoting D 125/6A. Closing date May 8, 1956. [5848

LABORATORY assistants are required in the research and development laboratories of a group working on a guided missile system; some experience of electronics essential; in addition one post calls for an applicant with knowledge of physics; successful applicants will be encouraged to improve their theoretical and practical knowledge; good promotion prospects exist.—Please write, giving full details of age, qualifications and previous experience, quoting Ref. 74, to: The Personnel Manager (Technical Employment), de Havilland Propellers, Ltd., Hatfield, Herts. [5709

ELECTRONICS engineer; an experienced engineer is required for design and development work on part of a guided weapon system; this is a post of great interest and responsibility; rapid promotion is possible for a man of initiative and knowledge; candidates should have at least 2 years' experience and be of degree standard, although applicants without this qualification will be considered.—Please write giving full details of age, qualifications and previous experience, quoting Ref. 75, to: The Personnel Manager (Technical Employment), de Havilland Propellers, Ltd., Hatfield, Herts. [5710

ELECTRICIAN required by a leading gold mine in West Africa; age preferably 25-35; general experience to include both a.c. and d.c. power supply and also v.h.f. radio; starting salary £74 per month; wife of new employee does not accompany on first tour, but marriage allowance of £180 per tour paid; permanent employment offered with tours abroad of 15 months followed by 5 months' leave on full pay; passages, furnished quarter and medical attention provided free; a staff assurance scheme is in operation.—Write, stating age and experience, to Box F2960, Whites, Ltd., 72-78, Fleet St., London, E.C.4. [5772

WAR DEPARTMENT requires Lecturers at R.E.M.E. Training Centre, Arborfield. Qualifications: An Engineering or Science Degree; lecturing experience preferable and specialist knowledge of either Electrical Engineering or Electronics, or Servo-mechanisms. Salary in accordance with Burnham Technical scale for Assistant B. Starting salary according to qualifications and experience; £115 non-pensionable allowance. Teacher's Superannuation. Full particulars and application forms from M.L.N.S., Technical and Scientific Register (K), 26, King St., London, S.W.1, quoting Ref. D 139/6A. Closing date, May 11, 1956. [5655A

WAR OFFICE requires an experimental officer (male) at Royal Military College of Science, Shrivenham, Berkshire, in Engineering Physics Branch of Department of Instrument Technology; degree in engineering or physics or H.N.C. in electrical or mechanical engineering, or equivalent qualifications and experience in instrumentation especially servomechanisms or computing (knowledge of guided weapon control techniques highly desirable); inclusive salary: £745-£920; starting pay according to age and experience; age at least 26, preferably under 31 years; prospects of permanency.—Full particulars and application forms from M.L.N.S., Technical and Scientific Register (K), 26, King St., London, S.W.1, quoting reference D 56/6A. [5696

ELECTRICAL Engineers and Physicists required by Air Ministry Establishment in Norfolk for development and adaptation of radio equipment pulse techniques including aerials, power supplies and displays. Applicants should have 1st or 2nd class honours degree in electrical engineering or physics with a bias towards electronics. Previous experience of airborne radar systems would be an advantage. Salary according to age, and post graduate research experience in range Senior Scientific Officer (min. age 26) £1,050-£1,165, Scientific Officer (min. age 21) £448 10s-£685 (Superannuable). Application forms from M.L.N.S., Technical and Scientific Register (K), 26, King St., London, S.W.1, quoting D.105/6A/EW. Closing date 8 May, 1956. [5814

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Applications should be addressed, in the first instance to Personnel Superintendent, quoting reference: WW/19.

SITUATIONS VACANT

MULLARD, Ltd., have a vacancy in their publicity division for a young man between 26 and 30 years of age with some knowledge of electronics and an ability to express himself in writing; duties are connected with the preparation of technical advertisements, literature and exhibition stands; acquaintance with printing techniques would be useful additional qualification; the post is permanent and pensionable and carries a salary in the range of £525–£600 p.a.—Replies, giving full details of age and experience, should be addressed to Personnel Officer, reference no. 799, Century House, Shaftesbury Avenue, London, W.C.2. [5752a

VACANCIES arise for good practical electronics engineers in a new department being set up to handle the overall assessment of reliability in the field of guided weapons; one or two of the positions offered will be senior appointments and the work will entail the collection of data, pursuit and analysis of faults at all stages from complete assembly down to basic detail; a short period of familiarisation with the equipment involved will be arranged.—Please write, in confidence, quoting Ref. 117, and giving full details of age, qualifications and previous experience, to The Personnel Manager (Technical Employment), de Havilland Propellers, Ltd., Hatfield, Herts. [5621

ENGINEER (min. age 26) required by Ministry of Supply, London Headquarters, to assist in development of radio and radar vehicle installations. Quals.—Higher School Certificate (Science) or equivalent, but a pass degree or H.N.C. in Electrical or Mechanical Engineering may be an advantage. Practical experience of installation of W.T. and radar equipment, preferably in mobile form, and knowledge of ancillary items such as aerials, power supplies and heat exchangers required. Salary within Experimental Officer range, £790–£960.—Application forms from M.L.N.S. Technical and Scientific Register (K), 26, King St., London, S.W.1, quoting D97/6A/EW. Closing date 14th April, 1956. [5795

V.H.F. radio electrician fully conversant with siting, installation, maintenance and servicing of V.H.F. equipment required at a Mining property in the Gold Coast; duties require some work to be undertaken underground in addition to equipment on the surface; permanent employment offered; starting salary £74 per month; tours abroad are of 15 months followed by three months' leave on full pay; wife of new employee does not accompany on first tour but marriage allowance of £180 per tour paid; passages, furnished quarters and medical attention provided free; a staff assurance scheme is in operation.—Write, stating age and experience to Box E5535, Whites, 72/76, Fleet St., London, E.C.4. [5835

TECHNICAL manager.—Imhofs invite applications from qualified electronic engineers for the post of technical manager of their radio and television service division; sound knowledge of modern electronic design and manufacturing techniques and experience in control of technical staff are required; ability to develop new ideas and to design testing set-ups will be an additional qualification; work includes contact with customers and interpretation of their requirements; salary in accordance with qualifications and experience; pension scheme.—Applications, in writing, giving personal details and an outline of previous experience, to The Secretary, Arthur Imhof, Ltd., 112-116, Oxford St., London, W.C.1. [5756

PHILIPS ELECTRICAL, Ltd., invite applications from young Graduate Engineers with an interest in the commercial development of amplifiers, tape recorders, record players and sound reproduction equipment; a knowledge of the application of these equipments for radio, television and public address purposes is desirable but not essential; applicants with a commencing salary of up to £800 p.a. will be made shortly in commercial departments of the London headquarters and prospects of further advancement in this rapidly expanding organisation are good.—Applications, in writing, giving details of age, qualifications and experience, should be addressed to the Personnel Officer, Century House, Shaftesbury Ave., London, W.C.2. Quote Ref. 795. [5757

ILFORD, LIMITED, The Physics Research Laboratory, Brentwood, Essex, requires a Graduate, preferably under 28, to design electronic instruments and process control gear for use in the Company's Laboratories and Factories. He will be engaged also in research projects involving the use of d.c. amplifiers, timing circuits and servo-systems. A basic knowledge of optics and photography will prove useful but is not essential. A phys.cs, electrical power or communications degree is equally acceptable provided it is accompanied by imagination, enthusiasm and a practical knowledge of electronic circuitry. The successful candidate will work with one Senior Research Engineer and several assistants responsible for assembly and maintenance of equipment.—Apply in writing to Research Director, Ilford, Ltd., Ilford, Essex. [5708

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SENIOR Engineer required for broadcasting service, Cyprus, on contract for two years in first instance; salary in scale (including overseas allowance and present temporary allowance of 9% of salary) £1,161 rising to £1,548 a year; gratuity at rate of £100–£150 a year; free passages; liberal leave on full salary; candidates, preferably between 28 and 35, should have sound theoretical knowledge and practical experience of operation and maintenance of M.F. broadcast transmitters and aerial systems and be able to control and supervise junior staff; knowledge of studio engineering and recording desirable.—Write to the Crown Agents, 4, Millbank, London, S.W.1. State age, name in block letters, full qualifications and experience and quote M2C/41601/WF. [5878

WAYNE KERR LABORATORIES have several vacancies for development engineers and assistants for work on the design of electronic test equipment; the company, which has an established reputation for integrity of design and quality of workmanship, is at present working on a wide range of projects, including precision audio oscillators, V.H.F. bridges, pulse generators and valve-wave equipment up to G Band; the designs involve such techniques as encapsulation, printed circuitry, electro forming and advanced sub-miniature design; salaries are decided by individual ability rather than by fixed salary scales.—Please write for an appointment to the Wayne Kerr Laboratories, Ltd., Sycamore Grove, New Malden, Surrey. [5780

SENIOR Lecturer in Electrical Engineering required by School of Electronics (Ministry of Supply), Ratlar Research Establishment, Malvern, Worcs., to teach Electrical Engineering Measurements and Servo-mechanisms to post-Higher National Certificate standard and to be responsible for organising laboratories. Opportunities are available for research. Candidates should have a university degree and good industrial and/or teaching experience. Salary payable in accordance with Burnham Technical Report, at present £1,065 by £25 to £1,215. Appointment is subject to Teachers' Superannuation Acts. A house may be available to successful married candidate after a time. Details and forms from Principal, to whom completed forms should be returned within 14 days of this notice. [5657

RADIO technicians required immediately by Air Ministry for service in ocean weather ship based Greenock. Voyages approximately one month, then 11-21 days in port. Applicants should have sound knowledge radio/radar to third year City & Guilds Telecommunications Engineering and practical experience in maintenance of ground radio, D/F systems and radar installations. Duties include radar operation. Engagement, subject to trade test, non-pensionable at first. Inclusive pay at age 25 and over is £506, rising by annual increments to £605. Lower rates below 25. Additional pay for excess hours. Food and accommodation free on board ship. Minimum six days' leave between voyages. Applications, stating age, qualifications and experience, to the Shore Captain, Ocean Weather Ship Base (W.S.4), Great Harbour, Greenock. [5756

SOUTH MANCHESTER H.M.C., Christie Hospital and Holt Radium Institute, Manchester, 20.—Physics Research Technicians. Applications are invited for the following posts in the Physics Research Department. (1) Research Technician. Salary £490-£600 p.a. The duties attached to this post include the design, construction and maintenance of a variety of physical and electronic equipment under the general supervision of a Chief Research Technician. (2) Student Research Technician. Salary £190 at 16 years of age, rising by £20 to £550. Candidates should have a practical outlook and possess a G.C.E. with Science or Mathematics. Prospects of promotion are good. Both these posts are superannuable and conditions of service are laid down by Whitley Council's P.T.B. Circulars 55/28 and 55/45. Applications, giving age, education, experience and the names of two referees, should be addressed to the Administrative Officer immediately. [5856A

RADIO Officer required by West African Airways Corporation based in Lagos. Applications are invited from radio officers with first-class flight radio telephony licence. Commencing salary £900 p.a. plus £500 p.a. expatriation pay—£1,300 p.a. Alternatively radio officers will be accepted with provisional licence at commencing salary £850 p.a. plus £300 p.a. expatriation pay—£1,150 p.a., providing they have sufficient previous communication experience. Arrangements will be made for conversion training in West Africa. In both cases a gratuity scheme is in operation of one-sixteenth of the annual salary for each completed period of three months' service, and is in addition to the salary. Liberal leave on full pay is granted, first-class accommodation with allowances for electricity and school fee, together with a U.K. domicile allowance for children at school under 18 years. A car loan scheme is available, together with a generous home-to-duty allowance.—Applications to Personnel Officer (Associated Companies), P.406, B.O.A.C. Headquarters, London Airport, Feltham, Middlesex. [5694

SITUATIONS VACANT

ELECTRONIC Engineers required for installation and maintenance of television broadcast transmitters; should have previous transmission experience, but television experience, whilst desirable, is not essential. — APPLICATIONS, giving brief details of background, should be addressed to Chief Engineer (ref. TXM), Pye, Ltd., St. Andrew's Rd., Cambridge. [5809

TRAINEE Television Service Engineer required by old-established London retail radio and electrical business. Good opportunity for keen man with aptitude for this work. Driving experience essential. State age and full details of career.—Box 0614. [5795

AIR MINISTRY requires two scientists in department of Scientific Adviser to lead teams concerned with study of (i) new techniques for improvement of R.A.F. electronic equipment (post A); (ii) technical supply and economic problems of operation of military aircraft and guided weapons systems (post B). Qualifications: Post A, first- or second-class hons. in physics or electrical engineering, with interest in wider aspects of physics and good background of research or practical experience in fundamentals of design and calculation of performance of radar equipments or some closely allied electronic equipment. Post B, first- or second-class hons. in mechanical, electrical or aeronautical engineering, with industrial or research experience and preferably an interest in applied statistical methods. Appointments in London on Principal or Senior Scientific Officer scales £1,245–£1,670 or £1,070–£1,245 respectively according to experience. F.S.S.U. available.—Application forms, quoting D488/5A, from M.L.N.S., Technical and Scientific Register (K), 26, King St., London, S.W.1. [5749

SITUATIONS WANTED

TECHNICAL writer, B.Sc. (Eng.), A.M.E.E., seeks change; prefer West London-Reading area.—Box 0961. [5781

EXPERIENCED TV Engineer, now with leading manufacturers; excellent knowledge of recording equipment, requires post as field service engineer covering Midlands. Car owner.—Box 0469. [5769

ENGINEER, married with family, requires progressive post in electronics field; no academic qualifications but 20 years' experience in all branches of the industry; anywhere in the world acceptable but accommodation essential overseas.—Box 1024. [5871

MANAGER (35) of large, well-known and profitable service factory (turnover £40,000) serving high-class local multiple radio and TV organization wishes to change; excellent qualifications, references and managerial record; special knowledge of sound recording and reproduction, and experience also in electronic designing and radio and line communications; present salary £1,400.—Box 0925. [5858

SITUATIONS WANTED

RADIO and TV engineer, age 30, 9 years experience leading makes, 2 years with present dealer; seeks position home or overseas; married, accommodation required.—Box 1054. [5887

TELEVISION distribution specialist, ex-Cranwell apprentice, 10 yrs.' experience with R.A.F., H.M.V., English Electric, Canadian General Electric and R.C.A. Victor in monochrome and colour TV service, microwave station maintenance, estimating, designing, selling and installing multi-channel TV distribution systems for complete housing estates, hotels and apartment buildings; would return to U.K. for good opportunity.—Box 0592. [5789

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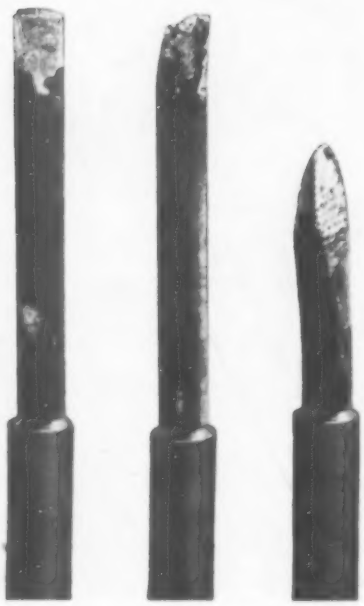

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